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the glass industry

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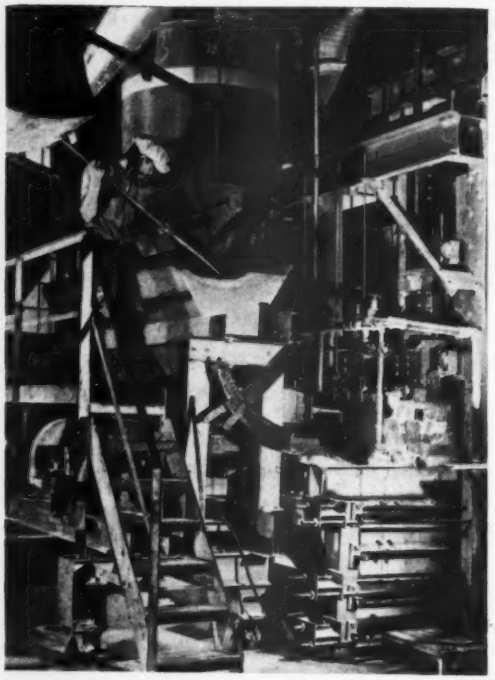

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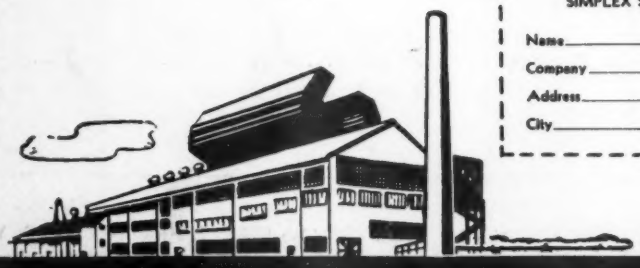

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THE GLASS INDUSTRY

VOLUME 35, NUMBER 11, NOVEMBER, 1954

GLASS DIVISION MEETING—

A Review of Papers and Panel Discussion

It was quite fitting that the Glass Division should convene in Pittsburgh this year for its Fall Meeting, October 8 and 9, for the area has long been noted for its varied and successful glass industry. In addition, the Division was exceptionally fortunate in having available Mellon Institute with its ample and comfortable auditorium and spacious lobby for this meeting. Registration was 269 men, of whom about 40 were accompanied by their wives. A dinner meeting of Committee C-14 was held at the University Club on Thursday night, October 7.

A most interesting session of eight papers and an afternoon seminar directed toward "the present trend in glass research" was compiled by the following committee: F. W. Mowrey, American Window Glass Company; J. W. Michener, Owens-Corning Fiberglas Corp.; and F. R. Bacon, Owns-Illinois Glass Company.

F. W. Mowrey was Chairman of the morning sessions. The meeting proper was opened at 10:00 A.M. on Friday morning, October 8, by H. R. Lillie, Corning Glass Works, who described his most interesting trip to Sweden last summer, at which time he attended a meeting of the International Commission on Glass at Vaxjö on June 16 and 17. On June 18 the Scandinavian Society of Glass Technology also met at Vaxjö (THE GLASS INDUSTRY, August 1954). This meeting was well attended by glass technologists from England, Belgium, Holland, Switzerland, Italy and Germany, as well as Norway and Sweden. Technical reports of this meeting have been made elsewhere and Mr. Lillie's report was augmented by pictures and slides. Other visits included the museum, Smaaland Province, Sweden, as well as the glass plants Kosta, Gullasfors and Orrefors.

The first paper, "An Investigation of Stresses in Glass Bottles Under Internal Hydrostatic Pressure", was written by Jo Morgan Teague, Jr., who presented it, and H. H. Blau, Ohio State University. Mr. Teague presented a unique way of studying and following the distribution of stresses in glass bottles. The first method employed was to make a duplicate model of various containers by means of Fosterite, an organic plastic developed by Westinghouse. These plastic models were quite susceptible to stress-analysis and served as a basis of comparison for actual bottle studies.

Actual bottle breakage was made on a lot of approximately 1,000 consecutive bottles from the same mold. So that various surface treatments could be compared, the bottles were divided into the following classifications: (1) bottles, pristine or untreated, taken directly from the annealing oven; (2) bottles, abused by surface contact; (3) bottles, grit-blasted on the outside.

There was a definite decrease in strength of the grit-blasted bottles when tested by hydraulic pressure. However, the strength of these bottles was quite uniform and less variable than those which were not grit-blasted. Although there was considerable variation in the strength of the pristine bottles, their strength was generally greater than those which were grit-blasted.

The bottles that were abused by contact also showed a great variation in strength, with the breakage being traced to the point of abuse. Grit-blasting also appeared to produce a fracture pattern whose origin was on the inside rather than the outside of the bottle. Electric gage studies were used to determine the magnitude of critical stresses.

In order to compare the value of stress analysis in a practical way, the pristine or untreated bottles were coated with a brittle lacquer. The brittle coating broke before the bottle did, and the pattern of cracking served as a means of showing visibly the stress pattern prior to bottle failure.

It was found that stress-distribution curves were valid estimates of stresses, and the various forms of testing checked quite well with previously gathered data. In general, the greatest tensile stresses were along the inside knuckle of the bottle.

This thorough investigation of a difficult subject was clearly presented by excellent slides that were easy to observe and follow. It is believed that if future papers will follow this example, much would be added to the enjoyment and clearer understanding of the subject matter.

Charles S. Pearce, General Secretary of the Society, presented some very interesting slides showing the development and progress of the Society's new headquarters on North High Street, Columbus, Ohio. The plan, architectural views and actual progress of construction were shown in detail. It is hoped to have this building ready for dedication December 4, 1954, and the new Society headquarters should be ready for occupancy sometime after the first of the year. The total building fund is now approximately $99,000 and, inasmuch as a goal of $100,000 has been set, it appears as though this amount will be fully subscribed to in the very near future.

The new headquarters has made use of glass and ceramic products to the fullest extent and will be entirely fireproof. The Society has long been in need of such a headquarters, and this office represents a culmination of efforts of many members. It was initiated and started by the late Ross C. Purdy, former Secretary of the Society, who devoted so many years of his life to its growth and development.

The next paper, "Ultrasonic Transmission Properties of Glass at Elevated Temperatures", by B. L. Steierman, J. C. C. Wu and J. M. McCormick, General Research Division, Owens-Illinois Glass Company, was presented by Mr. Steierman. This paper was a highly theoretical one, proposing the ultimate goal of stirring glass by means of ultrasonic vibrations with the hope of reducing seed count. The initial work was done at 400 kilocycles with barium titanate as a transducer and carried out on soda-lime-silica glass rods.

Additional work was attempted on glasses of varying thicknesses in a platinum crucible. There was little evidence of effect until 1000°F., with disintegration being observed at about 1400°F. The attenuation characteristics were apparently a function of the activation energy.

Water and oil have been easily degassed by ultrasonic vibrations, and it was observed that glass was degassed in extreme thinnesses, for example, a layer about equal in size to a miniscus.

Much remains to be done in this field of investigation, and tests involving other kilocycle treatment might be informative. This field of research will improve as better equipment is developed.

The next paper was "Compressibility of Binary Alkali Borate and Silicate Glasses at High Pressures" by G. E. Weir and L. Shartsis, National Bureau of Standards. The paper was presented by Mr. Weir.

The measurements were made by a technique used by Bridgeman of Harvard and Adams of the Geophysical Laboratory. Interest in high pressure chemistry, especially as related to various silicates, has been evident in recent years. This paper from the National Bureau of Standards described recent work directed toward the compressibility of binary borates and silicates.

The effect of intense liquid pressures on glass vessels was observed. The position of the piston at different atmospheres was determined and observations were made with decreasing atmospheres and compared with the effects on steel. In general, the compressibility of those borates and silicates decreased as the alkali content increased. Silicate compressibility was as a rule less than that of the borates; that is, alkaline silicates were less than alkaline borates.

It was also observed that a greater difference in compressibility existed between crystalline B_2O_3 and glassy B_2O_3 than existed between crystalline SiO_2 and glassy SiO_2.

Theoretical interpretation indicates that there are more and larger interstices in B_2O_3 than SiO_2; hence the borates compress more readily. Potassium ions (K^+) are larger in size and, therefore, fill the holes or interstices more fully, thus reducing the tendency of the potash glasses to compress. The sodium ion (Na^+) is next in size and the lithium ion (Li^+) the smallest; hence Li^+ offers the greatest compressibility. The effects of sodium were midway between those of potassium and lithium.

The question of what influence hygroscopicity or the tendency to pick up water might have on compressibility was discussed. Borates in general are known to have a strong tendency to pick up water. However, these effects were not studied in this investigation.

The afternoon session was a most interesting one and took full advantage of the conventional panel technique to provide ample discussion for questions raised by various members of the Glass Division. The panel selection and arrangements were very competently organized by J. R. Hensler, Bausch & Lomb Optical Company, who is Symposium Committee Chairman for the Division. Dr. E. U. Condon, Director of Research and Development, Corning Glass Works, was a most able moderator, and it was largely through his efforts that the panel functioned so efficiently.

Dr. S. D. Stookey, Corning Glass Works and Chairman of the Research Committee, prefaced a discussion of the panel by giving a brief history of scientific investigations, especially as applied to glass research. Dr. Stookey traced the technique developments in glass from the first machine operation, together with the first developments, in the optical glass field, up to present day practice. He stressed the work of such agencies as the U. S. Bureau of Standards, technical schools, and private and industrial research laboratories. In spite of over 5,000 years of work and effort, scientific control and fundamental development in the glass field are only in their infancies. Researchers are still in doubt concerning the actual structure of glass. Strength of glass is a moot question, with the relation of strength to organic materials just beginning to be realized. Dr. Stookey asked that the panel predict: *"What may be in store for the future in the glass industry?"*

The panel was composed of J. H. Schulman, Naval Research Laboratory; G. Slayter, Owens-Corning Fiberglas Corp.; R. Smoluchowski, Carnegie Institute of Technology; and W. A. Weyl, Pennsylvania State University. One of the first questions asked was, *"Where does glass research begin and end?"* The final compilation of answers appeared to be that glass research should begin with a study of fundamentals as to structure and composition and that there was practically no limitation or end to its development or progress; that is, research has encompassed such widely varied subjects as glass-to-metal seals, surface studies, surface coatings, the relation of glass fibers to plastics and other organic materials.

The question was asked, *"What benefits might be derived from radiation studies in glass?"* The answer was that luminescence of crystals and radiation work are fundamental to the optical properties of solids. Effects of impurities are also of extreme importance in studying

transmission and radiation properties. By a study of the fundamentals in solids alone, as well as the effects of impurities in simple solids, information will be provided for additional complex studies. The influence of the lattice structure was also stressed.

In answer to the question, "*Should glass research wait on further development in solid state reactions?*", the consensus was that there should be no waiting. It was pointed out that solid state reactions and glass research go hand in hand. Some solid state reactions can better be studied in glass than in crystals. It was believed that research in both fields simultaneously would tend to complement and aid one another.

In reply to the question, "*Why have physicists not conducted more research in the field of glass?*", it was pointed out that glass is not a simple material structurally and that the physicist desires to conduct experiments on single crystals and materials less complex than glass.

Dr. Condon asked whether or not studies on nucleation, metal crystals and the kinetics of metals might not be useful in revealing more fundamental information related to devitrification in glass. It was reported that considerable progress has been made in the fields of metals on the study of nucleation, incubation time and crystal growth that had led to a theory of surface nucleation: Once a nuclei is formed, it must grow. Rates of growth are not always quantatively determined or defined, but it is highly important to be able to observe the nucleus in order to follow its growth and development. Such phenomena are less discernible with glasses and, therefore, the study will probably be more difficult than one with metals. It is known that cadmium sulphide glasses are good examples of a means of study of devitrification because cadmium sulphide has numerous crystal forms which serve as a basis for various glass colorations.

Other questions raised were, "*What is the value of the effects of high pressure in chemical reactions?*" "*Is it possible to form silica (SiO_2) with different coordination number than is normally obtained?*" It was pointed out that other forms of silica have been produced by the use of quite high pressures and it is possible that the useful range of glasses may be expanded by this technique.

Another interesting question was, "*What effect will the arresting of cooling have on glass products?*" It was pointed out that glass fibers are an example of accomplishments made in extremeley rapid cooling of glass and that the ultimate strength of fibers can be altered by a varied heat treatment prior to the cooling of the glass. Other possibilities considered in the change in the properties of glass were the use of extremely low temperatures. It was pointed out that specific heat, dielectric properties, magnetic properties and conductivity might be altered by extremely low temperature treatment.

It was also suggested that glass research might be aided by solid state physics by first establishing a simple model for the constitution of glass which would serve as a basis from which questions could be asked. For example, what are the principle bonds involved in glass structure? What are the properties of one-dimensional chain and what are these dimensions in glass? The next step would be to progress to a more complex two-dimensional and then three-dimensional structure based upon fundamental information obtained from the more simple single-dimension glass. It was pointed out that metallic physics had progressed greatly from an initial study of metallic sodium and metallic copper.

The panel discussion closed with an attempt to define more specifically what was meant by the word glass, and the consensus seemed to be that "glass is a non-crystalline material that can be supercooled to a rigid condition without crystallization and also possess the property of being able to be fused again." The latter requirement was emphasized because many materials, such as plastics, do not possess this property of refusion. This type of meeting proved extremely popular as was evidenced by the spontaneous answers produced by the panel and the broad participation of the audience and entire Division. It is to be hoped that a meeting of this type will be offered again sometime in the future.

Dr. A. C. Siefert, Owens-Corning Fiberglas Corp., was Chairman of the Saturday morning session. The first paper to be presented was "A Fiber Method for Young's Modulus of Glass" by C. H. Greene, N. Y. State College of Ceramics, Alfred University. Dr. Greene's report was a preliminary one and described an interesting technique for measuring Young's modulus. The method was fairly simple, required a minimum of apparatus and used glass samples in the form of fibers for testing. Fiber testing offers some advantages because glass in fiber form can be cooled rapidly and thus be obtained in a state with a high fictive temperature.

"Most methods for measurement of the elastic coefficients of solids require either an accurately dimensioned specimen or somewhat complex measuring equipment, or both. This method for determining Young's modulus of glass takes advantage of a property of the material which is exploited in Littleton's well-known method for determining the softening temperature, i.e., the ease with which cylindrical fibers of well-controlled diameter can be drawn from small samples of glass with the aid of a blast lamp. Fibers made in this convenient way have the further advantage of exhibiting relatively high strength so that sufficient deflection to be measured readily may be obtained by cross bending on a moderate span.

"Fibers were usually made by collecting a ball of molten glass in the flame of a blast lamp and drawing the fiber just as for a softening point determination. While the glass was still soft in the mold, a handle of hard glass tubing was stuck to one end, the slug drawn out of the mold and another handle fused to the other end. The slug of glass could then be brought to uniform softness by rotating in the blast flame and drawn into a fiber approximately one millimeter in diameter." The fibers were bent between blunt steel knife edges approximately eight inches apart. Before the diameters were measured, each fiber was put on the knife edges and loaded.

Diameters parallel to and at right angles to the bent end were measured at one-inch intervals over the length of the span with a micrometer caliper. Loads were applied most conveniently by hanging pieces of wire from a small hook which was left suspended from the mid point of the fiber throughout the measurements. The loads were thus adjusted to use the full scale eyepiece micrometer employed for some measurements of deflection. Measurements were made on several types of glass as follows:

"Pyrex Brand" Heat Resisting Clear Chemical, Code 7740

6,107 $\pm$ 66 kilograms per sq. mm.

"Corning Brand" Clear Soda Potash Lead, Code 0120
5,765 ± 34 kilograms per sq. mm.

"Pyrex Brand" Ignition Tube, Code 1720
8,538 ± 58 kilograms per sq. mm.

Window Glass
7,091 ± 18 kilograms per sq. mm.

"Corning Brand" Capacitor Glass, Code 8871
5,761 ± 12 kilograms per sq. mm.

There was no evidence of drift in the value of Young's modulus with fiber diameter owing to variation in the rate of cooling. This method of testing offers considerable promise.

The next paper was a highly theoretical one backed by careful X-ray analysis. The title was "Glass Fibers Possessing Oriented Chain Molecules". The paper was presented by M. Goldstein, Mellon Institute. *What is the form or structure of molecules in glass fibers, links, chains or small rings?* It is believed that sodium ions tend to hold or form chains together.

Viscosity of glass and rate of shear might indicate linear chains. Chain orientation of a rubber band can be seen by birefringence as the band is stretched under X-ray observation. The elastic modulus and internal friction of glass are evidence of chain orientation.

A study was made in which fibers were drawn of simple sodium phosphates and definite birefringence shown by X-ray analysis. Simple glasses of sodium and potassium silicates were also drawn. None of the silicates showed orientation or birefringence. It was believed that this may be due to hand-drawn fibers and method of drawing or, possibly, the rate of cooling.

Phosphate glasses are known to be hygroscopic, and this fact may have been the cause of the orientation. No effort was made to protect these glasses from the action of atmospheric moisture.

The silicate glasses are known to be branched and stronger and may, therefore, resist birefringence. These qualities may be the reason that the silicate glasses did not show orientation and birefringence. The degree of orientation and randomness is a delicate property and demands a very precise measurement. The network theory may be in error, but considerably more work must be done to show that such is the case.

It was suggested that Brannon's method of measuring Young's modulus and modulus of rigidity might be a more delicate one for showing chain orientation and give better results than the X-ray technique.

The next paper, "Apparatus for the Measurement of the Visco-Elastic Properties of Glass", was presented by J. M. McCormick, General Research Division, Owens-Illinois Glass Company. Much interest in measurements of the internal friction in glass has stemmed from the interest of Zahner in metals. Complicated apparatus was needed, and a diameter response type of instrument was used to measure damping effects.

An electronic timer (in micro-seconds) was used to make a series of measurements in one decay and to determine where the decay was uniform. Light was allowed to strike a photocell and time of crossings between one slit and another measured. By recording the change in velocity of amplitude, the electronic timer performs with remarkable accuracy.

The paper was devoted to the development of precise electronic equipment to evaluate an extremely complicated property. Two photocells were provided, one of which was supplied with an extra pulse. Extremely small rods were used, and glass was sealed in the instrument. This sealing may be important for a consideration of coefficient of expansion. Cements may also be used to seal the samples in place. By use of a complicated torsion pendulum and the electronic timer, means were provided for measuring the damping or decay of oscillation with unusual accuracy. The basic operation thus depended upon the elapsed time.

Data on standard soda-lime glasses showed that a maximum value of the visco-elastic properties was reached at 150°F., falling off to 300°F. and then increasing at 400°F. This paper is a tribute to those of us who enjoy and appreciate the value of precise and accurate instrumentation. The results of this type of work will be more fully appreciated as more data are accumulated.

The next paper presented was "Some Physio-Chemical Comparisons of Glass Surface and Bulk Properties" by J. M. Lambert, Mellon Institute. The influence of surface conditions upon bulk properties of glass is well-known. This fact is particularly evident in the study of glass fibers.

The paper demonstrated that cationic diffusion offers marked possibilities in the study of surface properties of glass, especially durability. The rate of extraction of sodium from surface of glass and the penetration of the diffusion ray were plotted. An apparatus was provided for alternately dipping of glass samples from one beaker to another. The samples used were in the form of spheres, glass fibers and granules of plate glass. The time scale of sample transfer was arranged so as to provide a uniform diffusion to the surface of the sample by means of distilled water in CO_2-free air. Electrical conductivity methods were employed to determine the extraction of sodium. The results indicated that glass fibers and the plate glass granules were quite similar. The glass spheres, on the other hand, differed from both the fibers and the granules, in that the initial extraction of sodium was not so high. The chemical compositions used were of a window glass type. Some conjecture was made on the effect of structure owing to forming of the samples into spheres, fibers and granules.

This technique offers considerable fundamental value and the author is to be congratulated on his careful approach to the most complex properties of glass; namely, those at the surface.

The last paper, "The Production of Color Centers by X-Rays in Rather Pure Fused Silica", was presented by A. J. Cohen, Mellon Institute. Color phenomena of alpha quartz were believed to influence color centers in fused quartz. The measurements of the magnetic susceptibility of various centers was given to show possibilities of color centers.

The formation of some peaks was believed to be due to the oxidation and reduction of impurities. The effects of X-ray irradiation were also shown. The enhancement of color samples in air, sugar carbon and silicon were given. The enhancement was greatest in silicon, followed first by carbon and then by air. The color centers were definitely influenced by heating and quenching and heating in various atmosphere. This paper was an excellent pres-

(*Continued on page* 632)

STRAINS AND THE TRANSFORMATION REGION OF GLASS

By FRANCIS NAUDIN Eng. D.

TRANSLATED FROM VERRES ET REFRACTAIRES, JULY-AUGUST 1952

By KATE GAY EELLS* and NEILL M. BRANDT**

Part III

Abstract

The refractive index and birefringence as a function of temperature were studied for dense barium-crown, borosilicate-crown, light flint and dense flint. In the first part of the study, rates of heating and cooling were limited to temperatures at which the glasses would behave as perfectly elastic bodies. In the second part, the maximum temperatures involved in the heating-cooling cycles were in the transformation region.

Naudin found that as long as glass is not heated to temperatures high enough for it to lose its elasticity, neither original index nor original birefringence were permanently altered by the heating cycle. Refractive index was linearly related to temperature and may serve to define it. The birefringence at any time during the cycle was a function of the temperature gradient existing in the piece of glass at the time.

The effect on index of refraction and on birefringence of heating to temperatures within the transformation region was found to be influenced by the magnitude of the instrusion into the region, by the rate of entry, and apparently by the dimensions and geometric shape of the sample.

The variation of index of refraction was assumed to be an indisputable evidence of a structural change taking place in the transformation region. Naudin also attributes the variations in birefringence to be due, at least in part, to structural changes, particularly during the part of the cycle involving heating in the transformation region. Each heating-cooling cycle farther into the transformation region caused an increasingly appreciable alteration of the structure, and hence elastic constants in the elastic region, so that progressive variation occurred of birefringence due to a specific heating rate. NMB

Dynamic Study of Refractive Index and Birefringence as a Function of Temperature

In this third part, the behavior of four optical glasses during rapid heating is described. This dynamic study was divided into two sections. In the first, the maximum temperature reached during heating did not exceed the lower limit of the transformation range, i.e., the temperature range studied might be called the *elastic range*. In the second section, the glass was brought to temperatures within the transformation range as far as an approach to a fluid state.

I. The Elastic Range

In the first cycle of experiments, the maximum temperatures of the glass studied were such that the glass maintained its properties as an elastic solid.

In the first operation, the sample of glass in the shape of a truncated prism was placed in the furnace and brought to a temperature 100°C. below the lower limit of the transformation range; then it was cooled. In each of the following operations the maximum temperature reached was raised by 10°C. until the lower limit of the transformation range was reached.

The operation of the electric furnace differed according to the glass studied, but in all cases, the heating time did not exceed two-and-a-half hours.

A. Dense Barium-Crown. The value of the refractive index increased regularly throughout the experiment as the temperature rose from 25°C. to 530°C.

Curve II, Fig. 4, refractive index as a function of the temperature, has the appearance of a straight line. The increase in refractive index in the interval 25-550°C. is important and is calculated at 180×10^{-5}. The temperature ratio of the refractive index, $\frac{dn}{dt}$, has a value of 0.34×10^{-5} per centigrade degree.

In this temperature region, the glass behaved like an elastic solid and instantly acquired its refractive index at each temperature. Moreover, the index was a function of the temperature alone (at constant pressure) and may serve to define it. When the sample was cooled, it resumed the index value it possessed before heating.

Curve I, Fig. 4, represents birefringence as a function of the temperature and has the same appearance for all the glasses. It is reproducible in so far as the heating rate can be reproduced.

In the case represented by Fig. 4, the birefringence at departure was close to 1 mμ/cm. As the temperature rose, it increased rapidly to a maximum of 8.3 mμ/cm. toward 140°C. Starting from this maximum, the birefringence diminished to a constant value of 0.5 mμ/cm between 300° and 500°C.*

This birefringence curve is easily interpreted by the aid of the curve of the temperature distribution in the bulk of the glass during heating. This curve has a form identical with that of the stress.†

At 20°C. the whole mass of the glass was at uniform temperature. When heating began, a temperature gradient was instantaneously established in the furnace. The apex of the prism was hotter than its base. Hence, the layers close to the apex had a tendency to expand more than the layers close to the base. Measuring the birefringence, we found the algebraic sum "compression plus tension" which gave in this particular case an average compression between the apex and the base.

When thermal gradient varies, the average strain in optical retardation varies in the same direction. To the maximum of the thermal gradient near 140°C., there corresponds a maximum of strain; then a simultaneous drop from these two maxima; and finally a level between 300° to 500°C. of the thermal gradient and of the strain, calculated as an average compression of 0.5 mμ/cm path difference. When cooling started, the temperature gradient diminished to zero, changed sign and finally diminished to zero. It is the same with the strain, which diminishes to zero, changes sign (from compression to tension), and reaches a constant value close to that it had when heating was begun.

* Walton, N. Y.
** Mellon Institute, Pittsburgh, Pa.

† See Part II, Methods of Measurement, THE GLASS INDUSTRY, October 1954.

The difference between the birefringence of departure at 25°C. and that reached at the time of the level toward 400°C., gives the temperature gradient which was established in the glass once the heating reaches "steady state" conditions. It will be possible to call *dynamic* this temperature equilibrium in the region 300°-500°C.

Calculation of the optical retardation from compression requires knowledge of Brewster's ratio of the glass. Not being equipped with tools for its measurement, we circumvented this difficulty by calculating it from the composition of the glass. According to the different tables of Morey[1] and Balmforth and Holland[2], it was possible to assign to each of the glasses studied a Brewster's ratio.* This being granted, it was then easy to calculate the compression required to produce each optical retardation. Let δ be the retardation expressed in millimicrons per centimeter of glass traversed (μ/cm), and let C be Brewster's ratio in brewsters, then the ratio δ/C represents the compression in bars.

Thus for our dense barium-crown (DBC), Brewster's ratio is about —1.9. The strain corresponding to the maximum point on the curve of Fig. 4 represents a compression of 4.2 bars and on the level area at 400°C. an average compression of 0.1 bar; at room temperature the DBC was slightly in tension (0.25 bar).

The compressed state of the sample provoked a variation of its refractive index which overlaps the variation of refractive index due to pure temperature effect. If glass which is structurally perfectly homogeneous is under compression, its refractive index increases. Let Δn be this value, and* B the birefringence relation which exists between a sample without strain and an identical sample with strain. From studies made principally by Czapzki (Ann. Phys. *42*, 319, (1891)), it is evident that the ratio $\Delta n/B$ is constant, and for all the glasses whose lead oxide content does not exceed 30% equal to 2.5.

For the dense barium-crown studied, at the maximum of the strain toward 140°C. the index increase due to strain is about 0.12×10^{-5}; on the level, it drops to 7×10^{-7}. In all cases this increase was slight and seemed negligible compared to the thermal variations of the index. Hence, our method of refractive index measurement gives, for the small pieces we used, only the thermal variation of the index.

B. Other Glasses. A borosilicate-crown underwent an analogous thermal treatment (Fig. 5). Its refractive index increased linearly from 1.51580 to 1.51820 during heating from 20°C. to 540°C. Its temperature ratio, $\frac{dn}{dt}$, is of the order of 0.46×10^{-5} a degree.

Its strain curve has the same form as that found for DBC, except that the plateau between 350° and 540°C. is less marked. The curve of the strain during cooling shows the birefringence equality at 20°C. before and after heating. At the beginning of thermal treatment, this glass showed considerable strain which it maintained unchanged at the end.

For the light flint studied (Fig. 6), the refractive index increase always occurred linearly with a $\frac{dn}{dt}$ equal to 0.49×10^{-5} per centigrade degree. The strain was even more marked than in the preceding cases and the plateau at 300°C. to 450°C. disappeared and gave way to a continuous decrease. This sample, without strain at the beginning of thermal treatment, acquired slight strain.

For the dense flint (Fig. 7), the refractive index increase was always linear, of angular ratio $\frac{dn}{dt}$ equal to 0.72×10^{-5} per centigrade degree.

* See Table I.

TABLE I

	Dense Flint	Light Flint	BSC	DBC
Temperature of the strain maximum	150°C.	150°C.	140°C.	140°C.
Stress maximum in bars	0.8	4.6	3.5	4.2
Refractive index before heating	1.6219	1.5710	1.5158	1.5901
Refractive index after heating	1.6219	1.5710	1.5158	1.5901
Stress at 20°C. before heating, bars	0.2	—0.5	—0.3	—0.35
Stress at 20°C. after heating, bars	0.2	+0.6	—0.3	—0.50
Approximate Brewster's ratio, deduced from the composition	—2.5	—2.9	—2.9	—1.9

The birefringence curve shows the same appearance as

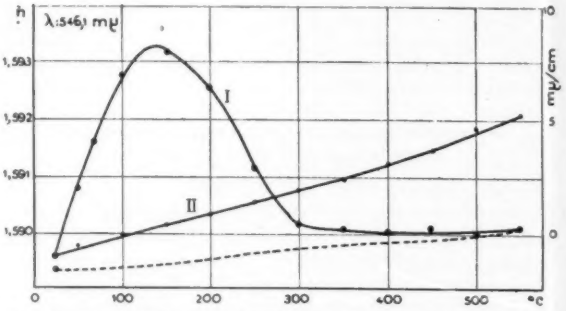


Fig. 4. Variation, as a function of temperature, of birefringence and of index for $\lambda = 546.1$ m μ Curve I, ordinates on the right, curve II, ordinates on the left. Glass: Dense barium-crown.

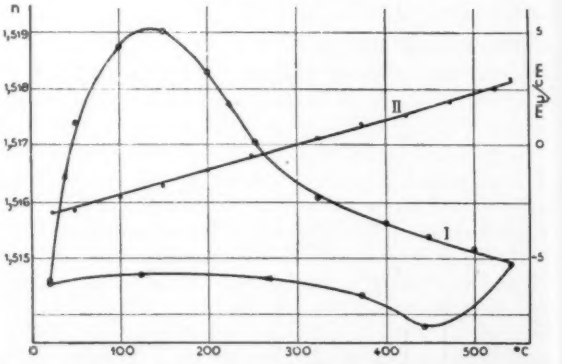


Fig. 5. Same legend as that of Fig. 4. Glass: borosilicate-crown.

the preceding, but in considerably less relief. This is due to a lack of fine annealing of the sample, to the use of too high a heating rate which diminished the maximum by causing the difference in temperature between the core and the surface of the sample to last too long.

C. Results. The numerical results: temperature of the maximum of strain, maximum stress in bars, refractive index before and after heating, temperature ratio of the index, strain at room temperature, 20°C., before and after heating, have been recorded in Table I for the four glasses studied. These tests were carried out over a temperature range where the glass acts about as an elastic solid.

Once the maximum temperature was reached, the glass was cooled without special precautions. A cooling rate of 7°C. a minute was maintained while passing through the first 100°C. The room temperature value of the refractive index before and after heating remained invariable at a precision of measurement of 5×10^{-5} for the four glasses studied.

What was true for the refractive index in this temperature range where the glass keeps the elastic state was confirmed, perhaps a little less accurately, for the strain. In Table I the values of the permanent stress in bars at room temperature before and after heating are recorded. For the dense flint and the borosilicate-crown, these two values are identical; for the light flint and the dense barium-crown, the slight differences lead to the inference that the heating was too prolonged. Without reaching the so-called transformation range, the temperature entered an interval where the transformation rate was no longer negligible compared to the heating rate.

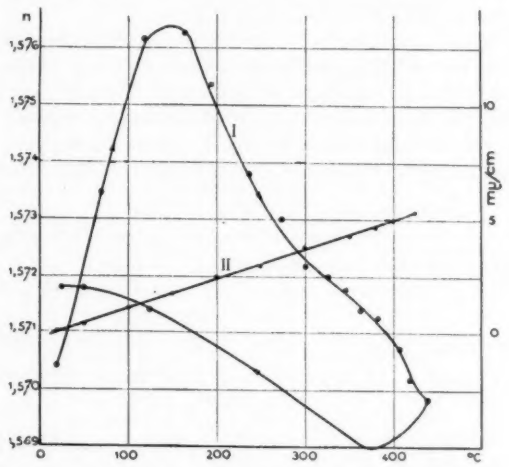


Fig. 6. Same legend as that of Fig. 4. Glass: light flint.

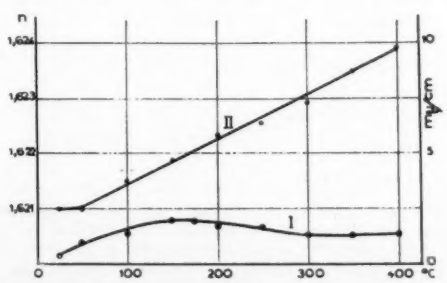


Fig. 7. Same legend as that of Fig. 4. Glass: dense flint.

II. Dynamic Study at the Temperature in the Transformation Range

Two groups of experiments were carried out successively:

First, at heating rates selected according to the type of glass, the sample was brought, in about two hours, to a maximum temperature close to the lower limit of the transformation range; then it was cooled to room temperature. In the second cycle, the sample was heated to a temperature 10°C. higher than the maximum temperature of the preceding heating, etc. The cycles were stopped when the glass became too fluid for index measurements to be possible. The results reported relate to a dense barium-crown, a borosilicate-crown and a light flint.

Next, these three types of glass, and a dense flint in addition, were heated to the fluid limit at the same rate. From these experiments we attempted to draw comparisons between the behaviors of the different glasses when hot.

A. Study of Three Glasses as a Function of the Temperature

(*a*) *Dense Barium Crown.* The transformation range for this glass begins near 600°C., as was shown by the sudden drop in the refractive index at this temperature. In five successive heatings followed by cooling, the maximum temperature of the heating cycle passed from 600° to 680°C. At this temperature, excessive fluidity caused deformation of the sample rendering index measurements impossible.

The variation of refractive index with temperature may be described as a rectilinear rise to the transformation range, then a sudden decrease as the temperature enters the transformation range.

The index increase for the heating from 25° to 600°C. was 290×10^{-5}, an index temperature ratio of 0.50×10^{-5} per centigrade degree. When the heating cycle peak temperature entered the transformation range, the index passed through a maximum then decreased very rapidly; the temperature ratio of the average index decrease is about -7×10^{-5}. In the course of the first three operations, heating to 600°, 610° and 625°C., there was no perceptible annealing or quenching, and the maximum refractive index appeared the same as the value 1.59250 for 600°C.

The cool from heating to 640°C. quenched the sample producing an index reduction, when cold, of 100×10^{-5}. The sample had an index of 1.58950 or 150×10^{-5} less than the maximum index of a fine anneal. In the heating to 660°C., the index measurements, less exact because of the deformation of the sample, gave only the trend of the phenomena.

The curves of strain as a function of the temperature are alike for all the heating operations. The maximum is always located near 150°C., and its absolute value greater with deeper penetration into the transformation range. Thus the influence of the structural inequilibrium, a consequence of a rapid incursion into the transformation range, makes itself felt even for the temporary strain created by the temperature gradient.

In the heating operation toward 640°C., after the level of birefringence following the entrance into the transformation range, a second very sharp maximum appeared. This maximum production of permanent strain[8] was

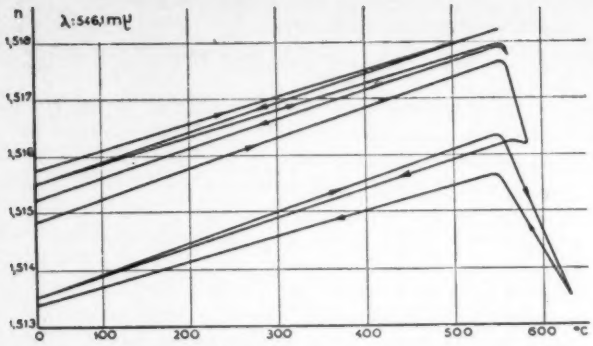


Fig. 8. Index variation for $\lambda = 546.1$ m μ of a borosilicate-crown glass as a function of the temperature during 10 successive heating-cooling cycles.

quickly released when the temperature rose a little, for then the glass began to become fluid. It must be noted that the strain curves for the two operations preceding this final heating show a rise at the end of run, which could be interpreted as a forecast of this second maximum at 640°C.

In the table below, the experimental data for the dense barium-crown has been assembled.

Dense Barium-Crown

Operation Number	Strain at 20°	Strain at 150° (1st Maximum)	Level of Strain near 600°C.	Strain near 640°C. (2nd Maximum)
1	— 2mμ/cm	8 mμ/cm	0.5 mμ/cm	4 mμ/cm
2	— 2	8	1	5
3	— 1.3	9	1	
4	— 0.9	10.5	1	
5	— 1.7	10.5	1.2	
6*	— 2			

* Operation 6 is the cooling following operation 5.

(*b*) *The Borosilicate-Crown.* The refractive index decreased at 540°C. in the first cycle. This decrease was confirmed more clearly in the following cycle to 550°C.; this value was selected as the beginning of the transformation range.

The curves of index as a function of temperature always have the same course: rectilinear rise, very sharp maximum at 550°C. and drop toward a stable value at the high temperatures. The temperature ratio of the refractive index has a value of 0.35×10^{-5} per centigrade degree from 20° to 550°C., and may reach -6×10^{-5} from 560° to 610°C.

We have arranged the following table of the refractive indexes at the various temperatures of the successive heatings.

Borosilicate-Crown

Operation Number	Index at 20°	Index at 550° (Maximum)	End of Heating: Index	End of Heating: Temperature peak reached in heating cycle
1	1.51575	1.51800	1.51800	540°C.
2	1.51575	1.51800	1.51800	550°C.
3	1.51550	1.51700	1.51780	560°C.
4	1.51525	1.51780	1.51770	570°C.
5	1.51475	1.51770	1.51625	580°C.
6	1.51375	1.51650	1.51550	590°C.
7	1.51360	1.51650	1.51500	600°C.
8	1.51360	1.51650	1.51440	610°C.
9	1.51350	1.51645	1.51425	620°C.
10	1.51350	1.51640	1.51350	630°C.
11*				

* Operation 11 is the cooling following operation 10.

The data from this table are presented graphically in Fig. 8. It shows the successive course of operations 1 to 10 with the cooling which followed.

The index of the fine annealed glass had a value of 1.51720; we had started from a somewhat quenched sample whose index had the value 1.51575. The heating treatments transformed the glass to a greatly quenched glass of index 1.51340, an index loss of 400 x 10^{-5}.

Figure 9 presents the room temperature refractive index of the sample as a function of the maximum temperature to which this sample had been brought. We again find a Lebedeff curve flattened in its characteristic manner at the beginning of the transformation range where the rates of transformation are low. The sample certainly did not

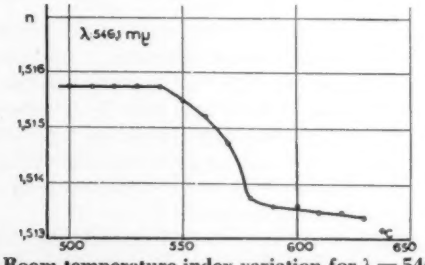


Fig. 9. Room temperature index variation for $\lambda = 546.1$ m μ of a borosilicate-crown glass as a function of the maximum temperature to which it was brought previously (Lebedeff's curve).

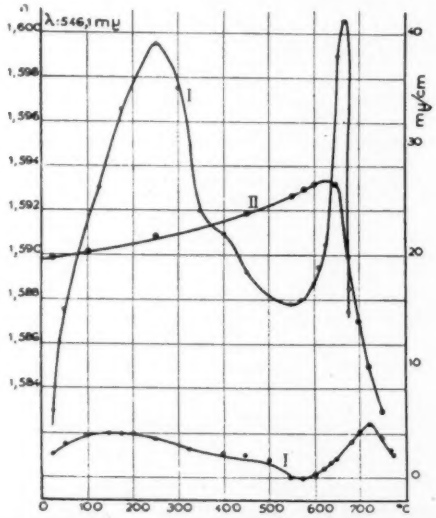


Fig. 10. Influence of the shape of the sample on the birefringence observed. Birefringence (ordinates on the right) variation of a dense barium-crown glass as a function of temperature. Curve I: parallelpiped block; Curve I′: prismatic shape; Curve II: index variation (ordinates on left, $\lambda = 546.1$ m μ) as a function of the temperature.

have time to reach structural equilibrium, hence, to acquire its stable index.

At the beginning of operation 1, the glass was practically without strain, although its index was not very near the maximum index of the annealed glass. The strain increased enormously with the temperature, passed through a maximum toward 150°C. and dropped slowly. Following a sort of strain plateau between 400°C. and 500°C., the strain dropped suddenly, near 500°, to a plateau of negative strain at approximately 530 to 630°C. The strain curves for operations 1 to 10 are similar except that with the increasing number of the operation, the curve shift upward; that is, the amplitude of the strain is accentuated.

A sample, originally in surface tension (birefringence at 20° = 7 mμ/cm), was brought, in the course of 10 heatings, to increasing temperatures in the transformation range. This glass acquired[4] permanent compression in the surface. This compression added algebraically with the tension which the sample possessed when cold at the beginning of the first heating. Therefore, when the sample was returned to room temperature after each heating, the tension was found to have diminished. After operations 3 and 4, the glass was without strain, and finally developed greater and greater compression as it was brought to higher temperatures in the transformation range.

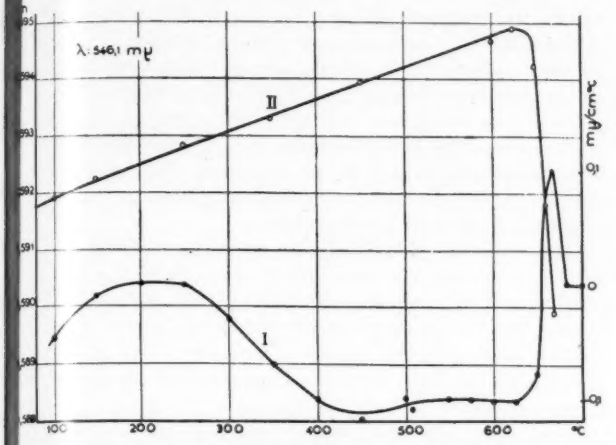


Fig. 11a. Simultaneous variations of the birefringence per °C along the optical path, (curve I, ordinates on the right) and of the index for λ = 546.1 m μ (curve II, ordinates on the left) as a function of the temperature. Glass: dense barium-crown.

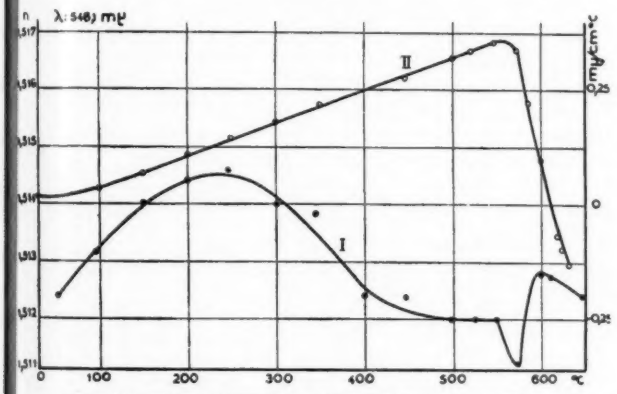


Fig. 11b. Same legend as that of Fig. 11a. Glass: borosilicate-crown.

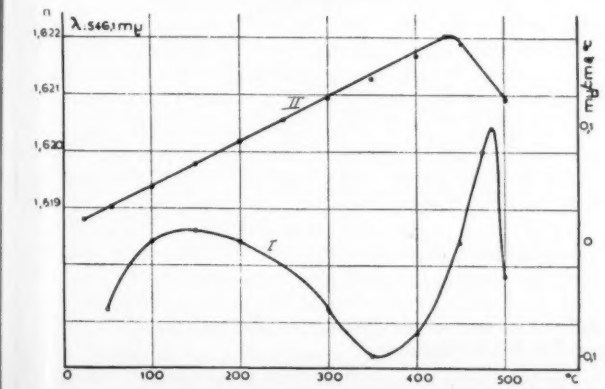


Fig. 11c. Same legend as that of Fig. 11a. Glass: dense flint.

Borosilicate-Crown

Operation Number	Strain at 20°C.	Strain at 150°C. (Maximum)	Strain in the Transformation Range
1	—7 mμ/cm	+ 7 mμ/cm	
2	—7	7	
3	—5	7	—2 mμ/cm
4	0	20	—2
5	0	20	—3
6	5	22	—2
7	10	27	—3
8	11	30	—3
9	10	30	—4
10	10	30	—4
11*			

* Operation 11 is the cooling following operation 10.

It must be noted that the deeper the penetration into the transformation range, the more important was the strain when cold, and the broader was the maximum strain peak at 150°C., corresponding to temporary strains.

(*c*) *Light Flint.* The transformation range for the light flint began near 440°C. In seven successive heating-cooling cycles, the upper temperature limit of the cycle passed from 440°C. to 510°C. At 510°C. excessive fluidity permitted sufficient deformation of the sample to make optical measurements impossible.

The variation of refractive index appeared the same as for the glasses previously studied: linear rise of the index to a maximum at the beginning of the transformation range with a slope of 0.47×10^{-5} per centigrade degree.

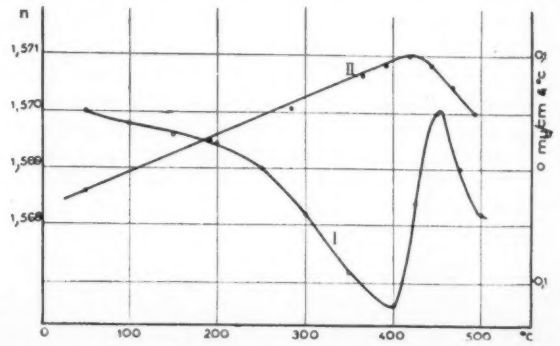


Fig. 11d. Same legend as that of Fig. 11a. Glass: light flint.

As the temperature entered the transformation range, the index began a decrease with a slope of -2×10^{-5} per centigrade degree.

The curves of strain as a function of the temperature are alike for all the heating-cooling operations. The first maximum is reached near 150°C., then the curve drops to a plateau between 300° and 500°C. After 500°C. the birefringence decreased rapidly through zero and changed direction, finally returning to a stable zero value for temperatures within the transformation range. This sort of minimum of birefringence must be similar in nature to the birefringence maximum encountered in the transformation range with the other glasses[3].

The strain at departure of each operation was essentially equal and opposite to that which was generated when the transformation range was approached. It was then that the glass was in the structural state corresponding to that temperature, and the cooling rate was great compared to the transformation rate, since there was no break of equilibrium during cooling.

(*d*) *Results.* The study of the dense barium-crown made more particularly evident a phenomenon characteristic of the evolution of birefringence as a function of temperature. In the transformation range, the birefringence curve as a function of the temperature showed a second maximum or a minimum (cf. the light flint) whose importance is primordial for the generation of permanent strain when cold.

Mme. Winter[4] pointed out as early as 1948 that the appearance of permanent strain in glass takes place, not at cooling as was indicated by Adams and Williamson, but at heating above a certain temperature limit which involves the transformation range.

Mme. Winter and myself resumed these experiments substituting a truncated prism[3] for the original slab shaped sample of glass. For all the types of glass studied, the temperature at which strain appeared was the same as that of the sudden variation of refractive index with the temperature. It is therefore indisputable that the phenomenon of birefringence increase is located in the transformation range. In this temperature interval, strain is created in glass by internal changes more complex than those explained by the solidification of the outer layers when the inner layers are still plastic.

This second maximum of the birefringence-strain temperature curve in the transformation range did not always appear clearly in all the experiments. It was sometimes impossible to raise the temperature high enough to obtain it without causing the glass to slump and make index and strain measurements impossible.

Light Flint

Operation Number	Strain at 20°	Maximum Strain at 150°	Strain in the Transformation Range
1	0 mμ/cm	15 mμ/cm	—5.2 mμ/cm
2	5	18	—1.2
3	5	20	—5.5
4	4.5	24	—5
5	4.7	20	—5
6	5.5	18	—5
7*			

* Operation 7 is the cooling following operation 6.

The more or less clear appearance of this second maximum on the birefringence-temperature curve is determined by the choice of heating rate, the properties of the furnace and probably variation of the viscosity of the glass with the temperature.

Having determined by experiment an optimum heating rate for the dense barium-crown, we made the same experiment on four kinds of glass: dense barium-crown, borosilicate-crown, dense flint and light flint.

To emphasize this second maximum of strain, we plotted the temperatures of a fixed point in the furnace against the ratio of optical retardation divided by the thermal gradient in centigrade degrees. The name thermal gradient was given to the difference in temperature expressed in centigrade degrees which exists along the optical path of the polarized light. It is quite evident that the temperature gradient is not completely eliminated by this device, but the curves for the four glasses are more symptomatic with this representation.

The refractive index variation as a function of the temperature is also recorded in Fig. 11a, b, c, d. The first conclusion from the examination of these four curves is the absolute coincidence between the sudden drop in refractive index and the sudden rise in the value of the internal strain when the temperature reached the transformation range.

These two phenomena, index variation and birefringence variation, begin exactly at the same temperature of the transformation range for the barium-crown; for the light flint the strain phenomenon is 10°C. ahead; for the dense flint some thirty degrees. For the borosilicate there is absolute coincidence between the beginning of the second maximum and the beginning of the transformation range; but this maximum is the minimum we had observed in our previous tests with the light flint. These differences in behavior are a function of the heating rate in relation to the nature of the glass. The studies continue in order to find the reasons for these variations.

A second inference is deduced from the observation of these curves. The absolute value of the second maximum is an increasing function of the refractive index of the glass. The values of the maxima: 0.1 for the BSC; 0.17 for the LF; 0.2 for the DBC; 0.2 for the DF, are in the same respective order as their refractive indexes: 1.514; 1,569; 1.590; 1.618. It will be necessary to confirm this series on a larger number of glasses.

The LF, DF and BSC were quenched glasses whose refractive index was several units of the 3rd decimal below the maximum value of the annealed sample; the DBC was finely annealed. For the first three glasses, the quenched glasses, the thermal treatment modified the refractive index but slightly, a gain of about 20×10^{-5}; the annealed glass lost 230×10^{-5}. The strain at departure was not great for any of the four glasses. After heating and having once returned to ordinary temperature, the strain doubled for the BSC, tripled for the LF and the DBC, and remained the same for the DF. Thus the variation of the mechanical strain and that of the refractive index, if they are produced at the same time and at the same temperature, do not follow a linear law.

B. Influence of the Shape of the Sample on the Birefringence

For studying the birefringence as a function of the

(*Continued on page* 628)

GUARDING VS. DISCIPLINE DEBATED AT GLASS SAFETY SESSIONS

Increased interest in the National Safety Council's Glass and Ceramics Section was evident at the annual conference held in Chicago, October 18 and 19, where more than 50 members listened to two high caliber speakers and witnessed a lively debate by a panel of four authorities.

General Chairman William G. Hazard opened the seventh session of the Glass and Ceramics Section with the comment that he and his officers were pleased to note that not only many representatives from the glass industry were present, but others as well because "safety is everybody's business."

Mr. Hazard (Owens-Illinois Glass Company), the retiring Chairman, called for the election of officers for 1954-55 as the first order of business. The nominating committee, consisting of J. C. Dittmer, National Lead Company, T. R. Donoghue, Pittsburgh Plate Glass Company, and H. V. Gardner, Owens-Illinois, listed the following slate of officers for the ensuing year:

General Chairman, Harry A. Jackson, Frigidaire Division, General Motors Corporation; *Vice Chairman,* Nelson B. Ingalls, The Norton Company; *Secretary,* C. C. Ruddick, Pittsburgh Plate Glass Company. *Program Committee,* John D. Fullen (Chairman), Kopp Glass Company; Fred G. Anderson, Corning Glass Company; J. C. Dittmer, National Lead Company; H. V. Gardner, Owens-Illinois; James L. Morris, The Federal Glass Company; John P. Stephenson, Ball Bros. Company; and Thomas R. Donoghue, Pittsburgh Plate Glass Company.

Membership Committee: Nelson B. Ingalls (Chairman), The Norton Company. *Newsletter Committee:* Karl W. Steinkraus (Chairman), Owens-Illinois. *Engineering and Health Committee:* William G. Hazard (Chairman), Owens-Illinois, and E. L. Wray, Ball Bros. *Safety Program:* Clinton Ballinger (Chairman), Owens-Illinois, and H. V. Gardner, Owens-Illinois. *Safety Contest Committee:* Jim Morris (Chairman), Federal Glass Company, and J. H. Gattrell, Blue Ridge Corporation. *Association Committee:* Paul E. Garrett (Chairman), Harding Glass Company, Russell Frank, Ferro Corporation, and J. C. Dittmer, National Lead Company. *Staff Representative:* L. W. Dutton, National Safety Council.

The Nominating Committee, through Mr. Gardner, recommended that the general chairman fill in with new people the committees' vacancies in order to "keep new blood in the organization". Mr. Gardner then presented, as a token of the Section's appreciation, a colorful scroll to Retiring Chairman Hazard.

As his final item of unfinished business, Mr. Hazard introduced Clarence J. Muth, Manager, Industrial Safety Division, Milwaukee Association of Commerce. In acknowledging the introduction, Mr. Muth remarked, "Here is one Hazard I hope we never lose in the glass and ceramics industry!"

Mr. Muth, who has served since 1930 in many advisory capacities on national safety committees, said that the subject of his talk, "Humanizing Your Program", runs through the entire gamut of industry. "Self-preservation, the desire to live, has always been the first law of humanity. Why, then, is there a need for a safety program? Why is there a need to protect men against themselves?"

To bring his point home, Mr. Muth uttered cause for alarmed thinking: "While I'm talking in the next 30 minutes, 11 people will be killed in accidents. Worse, 1,400 will be dead by the end of this week-long Congress. That's why we need safety programs."

"Look at the areas of man's existence," he went on, illustrating with chalk and blackboard. "First, there's his place of existence, his place of abode. Last year there were 29,000 deaths in homes, and a third of these were employees of the homes. Last year, in the place of work, there were 15,000 workers killed on the job—a dangerous area of existence. Third is the recreation area of man—16,000 killed at play."

The fourth area, Mr. Muth explained, is the *public* area, where man must move from home to work to recreation, the area of traffic where 38,000 Americans met death last year. "The hourglass of death runs its course every 60 minutes. In that time, 3.3 deaths by accidents will occur not too far away from us. In the five and one-half minutes I've been talking, somebody has been killed."

How is this distracting situation to be solved? The best approach is in the field of human relations, Mr. Muth feels, evolving a formula of life conservation. "Take a three-legged stool," he said by way of illustration. "It never wobbles. The first leg of your stool might be called the 'challenging objective', the thing that guided you and I into safety work. The objective is the list of figures I've just quoted. Second leg: 'effective organization and preparation' to combat these fatalities. Third leg: 'a practical program of activity'. This protects the worker just as much as glass is a protection through which you can enjoy the outside scenery through a wall of glass regardless of weather conditions."

In a breakdown of the "three legs of the stool", Mr. Muth went on to say that the "challenging objective" is human life at stake, and the urge of others to preserve this life. As for "effective organization", glass people must "first secure the facts behind their accident rates" just the same as any other industry. "Get these facts through effective leadership," he suggested, "and stimulate employee and public attention towards the need for greater safety measures to eliminate the causes of accidents."

In Milwaukee, he explained, he found that only 10 to 15% of accidents in industrial plants were through mechanical (and engineering) failure, while 85% of all accidents happened because of a lack of alertness by human beings, "thus there is a vast field for safety education among the *human* elements. Education is one of the 'Three E's' of safety: Enforcement, Engineering and Education. The point of attack for you and for us in Milwaukee is industrial enforcement of safety work, and already we have found that twice as many people are now killed *away* from their jobs. We're not interested in making money at the expense of human life and suffering. Since safety is good business, a good program must start at the top."

What are the essential characteristics of a good safety leader? To "humanize" the safety program he must: (1) Like people because our basic product is "people". (2) Have the common touch, mix well with employees. (3) Un-

derstand that each employee's life is the most precious thing he has to offer. (4) Place his employer's and employees' interest on the same level. (5) "Know his stuff" on safety practices. (6) Be able to *sell* safety to management and to employees. (7) Have an intense yearning to learn more about his job which is to protect life.

Following a question-and-answer period, newly-elected Chairman Jackson introduced the next speaker, Francis L. Brannigan, Safety and Fire Protection Branch, U.S. Atomic Energy Commission, Washington, D.C.

The AEC was confronted with a "stickler of a problem in safety", according to Mr. Brannigan, because "during the war our uranium plants were thrown together hurriedly and we were immediately confronted with chronic radiation effects on the workers." Today, with the Atomic Energy plants being the tremendous size they are, safety measures are strictly adhered to by all employees, not only through safeguards, but through an intensive program of education.

"We've had to walk a tightrope in handling employee safety," Mr. Brannigan said, "since most old timers scoffed because they'd been going along for years without dropping dead from radiation effects."

Before joining the Commission, Mr. Brannigan said, he had the popular conception that the plants were filled with "platoons of scientists and nobody else. Imagine my surprise when the first person I saw was a laborer pushing a wheelbarrow full of raw materials. Further study of employee level inspired us to produce a slide film directed to the thinking of a fourth grade-educated person." This film was shown to the audience, and all expressed enjoyment of it regardless of the high education of all members. Subjects covered in the film were intensely interesting because of public fascination with the term "uranium".

Directed to newer employees of the Commission and to "refresh" the veterans, the film covered such facets as: "Radiation—how do you handle it? Are you afraid? Are you a showoff? Or are you careful?; Radiation is a natural force like electricity; Man has learned to handle electricity safely; Radiation is like electricity—it can be used safely in small amounts; Man has been exposed to some radiation at all times; No one can get a harmful dose in a short time; Follow work methods set up here and you can work your lifetime safely."

Mr. Brannigan explained that safety engineers in the plants hover over the workers like mother hens, checking dust exposures and badges that are chemically treated to turn dark when exposed to radiation. Too, all employees take regular "breath" tests and have urine analyses at intervals, plus annual or semi-annual physical examinations. Plant engineers also keep regular check on normal occupational hazards found in any type industry.

"We have an excellent safety record along with the chemical industry," Mr. Brannigan declared, "and strangely our highest fatality record is in the *construction* of our plants, with electrocution next."

The second day's program was devoted to a spirited debate, with the audience itself providing the rebuttal period. Subject: "Resolved, that guarding will prevent more injuries than (will) discipline."

The affirmative team was made up of Milo W. Grey, Safety Director, Weirton Steel Company, and D. D. Mateer, Supervisor of Safety, Pittsburgh Works Division, Jones and Laughlin Steel Corporation. On the negative side were R. C. Bauer, Safety Engineer, Tar Products Division of Koppers Company, Inc., and Clyde C. Ruddick, Assistant Safety Director, Pittsburgh Plate Glass Company. Moderator was H. V. Gardner.

Mr. Grey, first on the platform, defined "Guarding" from Webster: "To shield, protect, take precautions, make secure from injuries." He added that " to *guard* means to place controls on dangerous work conditions. It is a fallacy to believe that *discipline* will cut down the 85% of accidents caused by human error. We can show ten tested ways to prevent accidents by *guarding* in all meanings of that word."

He explained that he would spell out, along with his team mate, a number of these methods. First is inspection. Regularly scheduled inspection of machinery will uncover defective machines which can be taken out of service before they hurt somebody. This includes all equipment. All the discipline in the world won't keep a man from falling off a broken ladder.

"Second is industrial hygiene, a specialized and technical field. These engineers seek to protect employees from unhealthy working conditions. They analyze all materials to be used in the shop, and if they are not safe to work with but must be used, precautions such as gloves or masks are used. All the discipline in the world will not prevent a man from absorbing lead or inhaling powder.

"Third—physical examinations to prevent accidents. Engineers, drivers, operators of big machinery should be examined once or twice a year to find any changes in vision of hearing. Untold accidents are prevented in this way. All the discipline in the world will not prevent poor hearing, vision or a bad heart.

"Fourth is housekeeping. This means not only a clean floor in the shop, but also proper stacking of materials, for instance, so that they do not topple when bumped, which could only result in crushed hands or feet. Other examples of poor housekeeping: materials stacked on stairs and in aisles, open pots of oil or grease left underfoot, steel bars stacked at angles against walls. There is a proper *guard* for the appropriate place and time. Guarding to *prevent* accidents does just that!"

In the negative approach, Mr. Ruddick agreed that "guarding is very necessary, but is it *enough?* Has a vast improvement in the safety picture been brought about by guarding? Certainly not! This improvement has been done by training and education. Some plants now give a prospective employee a safety aptitude test before he begins his job.

"Does the indoctrination of the new man stop there? No, for he keeps on learning safety rules right in his own department. From the beginning, his foreman orients him and shows where the safety hazards are, then as he works under an older employee, he learns the proper use of machines and tools."

Mr. Ruddick went on to say that many plants have safety meetings in their auditoriums, display posters prominently and even have safety contests with worthwhile prizes, and have organized emergency brigades, "all this since 1929 to bring down remarkably the number of fatalities. It has all been done by fair and forceful rules. Training is still the important answer to prevent injuries, for training has far-reaching results."

Mr. Mateer, coming back for the affirmative, said that human nature being what it is, "we must even barricade

(*Continued on page* 626)

NUMERICAL DATA FOR THE CALCULATION OF THE THEORETICAL HEAT INPUT FOR THE FUSION OF GLASS

The Second of a Series of INFORMATION CIRCULARS OF THE INSTITUTE OF SILICATE RESEARCH

Part II

As an illustration of such calculations, Kröger gives complete tabulations for batches of a Fourcault sheet glass, a lead crystal glass, a chemical apparatus glass and an ordinary container (hollow) glass, with their practical compositions. Of these series of calculations, we select here the one for the sheet, and the one for container (hollow) glass, the latter to illustrate the emphasis of intermediate reactions and ternary compounds assumed in the product of the batch conversion.

Fourcault Sheet Glass. See Tables IV and V of composition.

Reactions in the batch:		Calories required
Polymorphic inversion in Na_2CO_3 (.1887 x 424)	= 80 Cal/kg	
in Na_2SO_4 (.0493 x 9850)	= 485 "	565
Dissociation of dolomite (.0624 x — 1600)	= — 100 Cal/kg	
Formation of $Na_2CO_3.CaCO_3$ (.1069 x — 2070)	= — 221 "	— 321
Decomposition of Na_2SO_4 by C (.0123 x 51780)	= 637	
Reaction of Na_2SO_4 and Na_2S with SiO_2 (Qu.) $\rightarrow Na_2Si_2O_5$ (.0123 x 171000)	= 2202	2839
Reaction of Na_2CO_3 with $SiO_2 \rightarrow Na_2SiO_3$ (.1887 x 21720)	= 4090	
Reaction of $CaCO_3$ with $SiO_2 \rightarrow CaSiO_3$ (.1693 x 20560)	= 3480	
Reaction on $MgCO_3$ with $SiO_2 \rightarrow MgSiO_3$ (.0624 x 23850)	= 1488	9058
Heats of fusion of $Na_2Si_2O_5$ (.0493 x 8500)	= 419	
Heats of fusion of $CaSiO_3$ (.1693 x 13400)	= 2268	
Heats of fusion of $MgSiO_3$ (.0624 x 14700)	= 917	
Heats of fusion of albite (.00496 x 26300)	= 130	3734
Heat of dissolution to homogeneous sodium disilicate glass (.1887 x 5080)	= 959	
$(Na_2Si_2O_5)_{glass} \rightarrow (Na_2O.4.44SiO_2)_{glass}$ (.4583 x 3280)	= 1503	2462
Heat of mixing and homogenization of Ca-Mg-Na silicate glasses	neglected	
Sum of the heat effects of batch reactions		18337
Heat input to bring the glass from room temperature to 1500°C.		
Specific heat, $\bar{c}_p$, calculated from the increments and Sharp-Ginther's formula	= 0.2964	
Heat input from 20°C. to 1500°C. = 0.2964 x 99.35 x 1480		43600
Heat contents of CO_2 and SO_2:		
Specific heat of CO_2 from 20°C. to 1500°C. = 0.285		
Heat content of CO_2 = 0.285 x 19.58 x 1480	= 8320 Cal/kg	
Specific heat of SO_2 from 20°C. to 1500°C. = 0.195		
Heat content of SO_2 = 0.195 x 3.16 x 1480	= 933 "	9253
		71190 (for 99.34 kg)
Sum of all the heat effects, calculated for 100 kg glass: 71190/0.9935		71661 Cal

Container Glass. See Tables IV and V of composition.

The heats of reactions were calculated by Kröger from the equilibria pressures of the reactions if combined with a gas evolution (CO_2 here exclusively). The average temperature of these determinations was 600°C., which is the reason why the reactions were all related to this as the standard temperature. The final temperature of fusion to homogeneous glass was chosen as 1000°C. Mix-

ing effects could not be considered because of lack of any data, and for the heats of fusion and the molecular heats of the ternary intermediate compounds, the assumption was made that they would not differ too much from the analogous data for ternary aluminosilicates, an assumption which has been criticized above (see preceding page).

			Calories required
Heat input to bring the batch from 20°C. to 600°C.:			
Inversion effect of Na_2CO_3 (0.2265 x — 424)	=		— 96
Formation of $Na_2CO_3.CaCO_3$ (0.1449 x — 2070)	=		— 300
Heat input to sand (1.116 x 15.15 x 580)	=	10,200 Cal/kg	
to Na_2CO_3 (0.2265 x 31.0 x 580)	=	4,070 "	
to K_2CO_3 (0.01086 x 32.0 x 580)	=	202 "	
to $CaCO_3$ (0.1449 x 25.70 x 580)	=	2,163 "	16,635
			16,239
Reactions at 600°C.:			
Reaction of $[Na_2CO_3.CaCO_3]$ with $[SiO_2]_{Qu.}$ forming $[2Na_2O.CaO.3SiO_2]$, and $[Na_20.2CaO.3SiO_2]$ (0.1449 x 174,500/3)	=	8,435 Cal/kg	
Reaction of these ternary silicates with $[SiO_2]_{Qu.}$ forming devitrite and $[Na_2Si_2O_5]$ (0.04830 x 22,770)	=	1,100 "	
Reaction of excess $[Na_2CO_3]$ with $[SiO_2]_{Qu.}$ forming $[Na_2Si_2O_5]$ (0.0186 x 20,090)	=	1,640 "	
Reaction of $[K_2CO_3]$ with $[SiO_2]_{Qu.}$ forming $[K_2Si_4O_9]$ (0.01086 x 10,540)	=	115 "	
		11,290	11,290
Heat contents of the reaction product (without CO_2) increased from 600°C. to 1000°C., added heat content of feldspar from 20°C. to 1000°C.:			
0.04830 $[Na_2O.3CaO.6SiO_2]$ ($\bar{c}_p$ estimated from the aluminosilicate), difference of heat contents from 600 to 1000°C.	=	3202 Cal/kg	
0.1782 $[Na_2Si_2O_5]$, analogous difference of heat contents	=	4205 Cal/kg	
0.01086 $[K_2Si_4O_9]$, analogous difference of heat contents	=	348 "	
0.01908 albite, analogous difference of heat contents	=	1240 "	
Sum of heat contents			8,995
Heats of fusion and dissolution, at 1000°C.:			
Dissolution of 0.4264 quartz in 0.1782 $(Na_2Si_2O_5)_{glass}$ forming glass 0.1782 $(Na_2O.4.4071SiO_2)$	=	1354 Cal/kg	
Fusion of 0.01086 $[K_2Si_4O_9]$	=	127 "	
Fusion of 0.04830 $[Na_2O.3CaO.6SiO_2]$	=	966 "	
Fusion of 0.01908 [albite]	=	500 "	
			2,947
Another version of this item in the calculation may be based on the assumption that the devitrite is incongruently decomposed; the corresponding computation is given by Kröger in this case:			
Dissolution of 0.4747 $[SiO_2]$ in 0.2265 $(Na_2Si_2O_5)_{glass}$ to form (0.2265 $Na_2O.0.9277\ SiO_2$) glass	=		+ 1,720
Decomposition of devitrite (0.04830) devitrite forming 1 $[Na_2Si_2O_5]$, 3 $[CaSiO_3]$, and 1 $[SiO_2]$ per mole, with a heat effect of	=	— 41,500 Cal/Mole	— 2,000
Heat of fusion of the new-formed $[CaSiO_3]$ (0.1449 x 13,400)	=		+ 1,943
Heat of fusion of 0.01086 $[K_2Si_4O_9]$	=		+ 127
Heat of fusion of 0.01908 [albite]	=		+ 500
			2,290
Because of the uncertainties inherent in both series of calculations, Kröger assumes the acceptable average data of both for the thermal effects of fusion and dissolution to be:			2,640
Heat content of 101.2 kg of the glass melt from 1000° to 1500°C.			
Specific heat between 20° and 1500°C. calculated from Sharp-Ginther's formula:		0.2973	
Heat content calculated up to 1500°C.			44,530
Specific heat between 20° and 1000°C. calculated from Sharp-Ginther's formula:		0.2805	

Heat content calculated up to 1000°C.		27,800
Difference of Heat Contents at 1500° and 1000°C.		16,730
Heat content of 16.823 kg CO_2 in the temperature range from 600° to 1500°C.:		
Specific heat of CO_2 from 20° to 1500°C.:	0.285	
Heat content between 20° and 1500°C.:		7,110
Specific heat of CO_2 from 20° to 600°C.:	0.250	
Heat content between 20° and 600°C.:		2,440
Difference of Heat Contents at 1500° and 600°C.		4,670
		60,625 for 1012 kg glass
Sum of all the heat effects, calculated for 100 kg glass: 60,625/101.17		59,910 Cal/100 kg

This result is rather remarkable because the analogous calculation of the same container glass by method (I) had given as a result 62,400 Cal/kg, i.e., with a difference of only 4.2% of the absolute amount. Kröger does not emphasize this favorable result as convincing for the real accuracy of both methods of calculation because they are involved with so many uncertainties and assumptions. Nevertheless, he concludes that the inclusion of the ternary silicates into the operations means an important approximation to the true mechanism of the thermochemical process of glassmaking.

But Kröger's results, in another way, are still highly interesting; namely, in comparison with the calculations of the heat balance diagram of Badger, et al. To a certain degree it is permissible to compare the glasses melted in both processes as discussed by Kröger and Badger; their analytical type is in the same class. Although the first is a sheet glass, the latter glass is for the manufacturer of electric lamp bulbs. For the calculations and the comparison, it is important that Badger in his studies considered a glass not melted from 100 per cent of fresh batch, but from a mixture of 35.3 short-tons of fresh batch, and 69.5 tons of cullet. The composition of the latter is not given, but surely it can be assumed to have had the same composition as the resulting glass. Another important difference in both calculations is the fact that in the fresh batch burnt lime containing some MgO (not limestone) was introduced. The end temperature of the glass melts was fixed by Kröger at 1500°C., and by Badger at about 1250°C. (2290°F.).

(*Continued on page* 630)

TABLE V.

Chemical Composition of the Sheet Glass Sample			of the Container Glass Sample	
SiO_2	71.79 kg or	72.1%	74.9 kg or	74.1%
Al_2O_3	0.51	0.5	1.942	1.9
CaO	9.48	9.6	8.124	8.0
MgO	2.51	2.5	...	...
K_2O	...	...	1.022	1.0
Na_2O	15.06	15.3	15.2	15.0
	99.35 kg	100.0	101.2	100.0

TABLE IV.

Composition of the Two Sample Glasses

	SHEET GLASS						CONTAINER GLASS					
Raw Materials	Batch kg	Batch kg.Mole	Glass	Glass kg	Gases evolved (kg) CO_2	Gases evolved (kg) SO_2	Batch kg	Batch kg.Mole	Glass	Glass kg	Gases evolved (kg) CO_2	Gases evolved (kg) SO_2
Sand	70	1.1660	SiO_2	70.00	...	...	68	1.11600	SiO_2	68.	...	...
Soda	20	0.1887	Na_2O:	11.70	8.30	...	24	0.22650	Na_2O:	14.03	9.97	...
Potash	...	...		...	...	...	1.5	0.01086	K_2O:	1.022	0.478	...
Sulfate	7	0.0493	Na_2O:	3.05	1.69	3.16	...	...	....	...	...	...
Limestone	10.7	0.1069	CaO:	5.99	4.71	...	14.5	0.14490	CaO:	8.124	6.375	...
Dolomite	11.5	0.0624	CaO: / MgO:	3.49 / 2.51	5.48	...	...	...	....	...	...	...
Na-Feldsp. (Albite)	2.6	0.00496	Na_2O. Al_2O_3. $6SiO_2$	2.60	...	...	10.0	0.01908	Na_2O. Al_2O_3. $6SiO_2$	10.0	...	...
SUM	121.8	1.57826		99.34	19.58	3.16	118.0	1.51734		101.177	16.823	

LETTERS TO THE EDITOR

The Editor
The Glass Industry

Dear Sir:

The August issue of THE GLASS INDUSTRY contains a publication, "Galvanic Potentials in Silicate Melts", which is practically a translation of my paper published in *Silicates Industriels*, April 1954, page 141.

The way this publication is written, it gives the impression that the information is based on experimental work of the Institute of Silicate Research. This is of the Pennsylvania State University, State College, Pa., where I did most of this work in the laboratory of Prof. W. A. Weyl. In my original paper I expressed my appreciation, but the translation does not mention that at all.

With the exception of Fig. 1, which is taken from a paper of Rindone-Marboe-Weyl, all pictures are taken from my publication. The writer of this Information Circular apparently wants to give the impression that the Institute of Silicate Research is active in this field.

In the same issue, there is a paper on "The Annealing of Flat Glass" where the original authors are mentioned in the subtitle. The paper clearly states that it is a translation. That is the way it should be done.

I certainly would appreciate it if you would look into this matter and publish this letter in your journal.

Very truly yours,
E. Plumat, Director of the Central Laboratory
Union Des Verreries Mecaniques Belges
Gilly, Belgium

* * * *

The Editor
The Glass Industry

Dear Sir:

Copies of the letters from Dr. E. Plumat and the Editor of *Silicates Industriels* forwarded to me and criticizing the form in which our Information Circular "Galvanic Potentials in Silicate Melts" was published in THE GLASS INDUSTRY are most distressing and it is my desire to publicly acknowledge these complaints and to correct any misconception as to our intention in the preparation of the review.

First, it is regrettable that inadvertently adequate acknowledgment was not given to the source of the figures which originally appeared in Dr. Plumat's paper in *Silicates Industriels*. We offer our apology to this publication for the oversight. Failure to mention the source of these figures can undoubtedly be traced to the fact that Dr. Plumat's name was mentioned four times in our commentary and this could have led us to feel that the origin of the figures was obvious.

Rather than to minimize the experimental work quoted, it was intended to praise Dr. Plumat for his magnificent work and certainly not to attempt to take credit for work done by others. As a matter of fact, it was felt that Dr. Plumat's work was considered to be of such importance as to be worthy of broader circulation in this country. The form employed in the publication in THE GLASS INDUSTRY seemed more suitable for additional comments which could not be properly included in a translation.

As further evidence of the high esteem in which we hold Dr. Plumat, we submit that the subject of galvanic effects in molten silicates and, in particular, Dr. Plumat's contributions, served as the basis of discussion of the second colloquium held at the Institute of Silicate Research at the University of Toledo.

We trust that this frank statement of our intentions will serve to clarify any misconception that may exist.

Sincerely yours,
Wilhelm Eitel, Director
Institute of Silicate Research
University of Toledo

L-O-F COMPLETES TWIN-GRINDING FACILITIES AT ROSSFORD

On October 2, C. W. Davis, Vice President of Libbey-Owens-Ford Glass Company, reported the beginning of production at the new giant plate glass polishing plant at Rossford, Ohio, giving Toledo the most modern complete plate glass plant in the world. All orders for quarter-inch plate glass are now being filled with the new twin-ground glass.

Even though the construction timing of the polishing plant was moved up three months, it was completed on schedule, Mr. Davis said. The former grinding and polishing lines were halted on the weekend of July 3, all of the machinery taken out, new machinery and much reconditioned polishing machinery reinstalled and made ready in the 90 days allotted for the tremendous task. The new polishing plant has a double moving line 967 feet long. The glass travels about 2,000 feet over all to be polished on both sides, moving up one line and down the opposite side.

The rotating polishing heads weigh an aggregate of 2,400 tons and the moving tables weigh 1,200 tons. It takes 17,000 horsepower of electric energy to drive the equipment and the control is by means of 800 individual motors. More than a million feet of electric wiring was used in setting up the controls.

The A. Bentley & Sons Co., general contractors, had as many as 766 employees at work on the construction job around the clock and they were supplemented by 230 Libbey-Owens-Ford men closely associated with that phase of plate glassmaking.

The first of the two big twin-grinding plants was put into operation about a year ago. It grinds the glass on both sides in a continuous ribbon 100 inches wide. The second of these big machines is wider, handling a continuous ribbon of glass 127 inches wide. On both machines the glass travels about 900 feet in a single ribbon before it is cut at the end of the grinding operation. The new polishing facilities will polish the glass from both twin-grinder plants ready for washing and delivery to the warerooms for cutting to order.

PACIFIC COAST BORAX TRANSFERS TECHNICAL MAN

The Pacific Coast Borax Company, Division of Borax Consolidated, Ltd., has recently moved Grover G. Collins to its Eastern Sales Office, where he will assist in the Technical Service and Product Development work for the company's Industrial Division.

Mr. Collins received a B.S. degree in Chemical Engineering from the University of Alabama in 1943 and has for the past eight years worked in the company's Research Laboratory.

Inventions and Inventors

Annealing and Tempering

Bulb-Stretching Machine. Fig. 1. Patent No. 2,683,331. Filed June 4, 1952. Issued July 13, 1954. One sheet of drawings. Charles Eisler.

This invention relates to improvements in a machine for stretching bulbs and is adapted for use in connection with bulb-forming mechanisms having a plurality of stations, such as the type wherein the bulbs are advanced from station to station.

As shown in Fig. 1, bulb 13 is stretched from its initial form to a different cross-section. In operation, one bulb 13 is positioned over the preferably tapered upper ends 40, 40′ and onto the finger uprights 27, 27′, and held in axial registry with the plunger 11 by the standard 14 which may be secured at its lower end of the casing 15. A supporting arm 41 is fixed at one end to the standard and extends toward the axial plane of the spreader bars. Spring plates 42, 43 are fixed to the arm and project from the sides to engage the bulb and hold it against the supporting arm and upon the spreader bar fingers. The free end 44 of the arm 41 is preferably of such outline that it will engage and steady the bulb. The free ends 45, 46 of the spring plates 42, 43 are preferably conformed to the cross-section of the bulb.

The patent contains 3 claims and the following references were cited: 202,631, Challinor, Apr. 23, 1878; 631,582, Rudolph, Aug. 22, 1899; and 741,823, Packer, Oct. 20, 1903.

Feeding and Forming

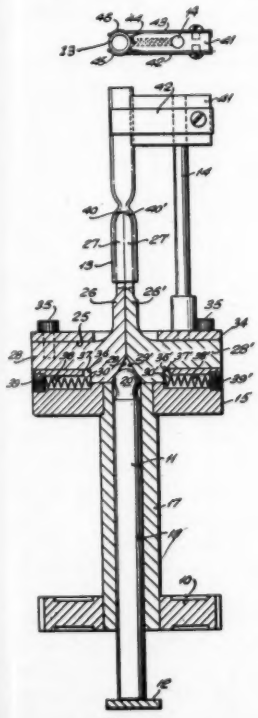


Fig. 1.

Glass Feeder Shears Equipped with Charge Drop Guiding Means. Fig. 2. Patent No. 2,681,530. Filed December 24, 1951. Issued June 22, 1954. Two sheets of drawings. Assigned to Emhart Manufacturing Company by Karl E. Peiler.

The object of this invention is to provide for ready adjustment of a charge guide in either direction laterally of the direction of movement of horizontally oscillated glass cutting shear blades without necessary interruption of the oscillatory movements of the blades or travel of the guide.

The shears are provided with associate drop guides cooperating with their blades during cutting to direct the severed charges properly toward the molds or other charge receivers and to prevent lateral batting of the upper ends of the severed charges between lower blades. The drop guide mechanism comprises a glass charge contacting guide member for the upper blade of each pair. The two charge guides thus provided are indicated at 434 and 435 in Fig. 2 and are associated with the blades 343 and 342. The guides are adjustable independently toward the cutting axes of the respective pairs of shear blades, i.e., toward the vertical axial lines of the suspended glass columns from which charges are to be severed and along the paths of movement of the associate upper blades toward the cooperative lower blades. The drop guides also are independently adjustable laterally of the paths of movement of their associate blades toward the cooperative blades.

The patent contains two claims and the following references were cited: 1,950,339, Barker, Jr., Mar. 6, 1934; 2,245,813, Pearson, June 17, 1941; and 2,412,268, Honiss, Dec. 10, 1946.

Glass Feeder Shear Mechanism Having Overlap Adjusting and Throwout Means. Fig. 3. Patent No. 2,680,937. Filed December 24, 1951. Issued June 15, 1954. Two sheets of drawings. Assigned to Emhart Manufacturing Company by Karl E. Peiler.

This patent is a division of co-pending application,

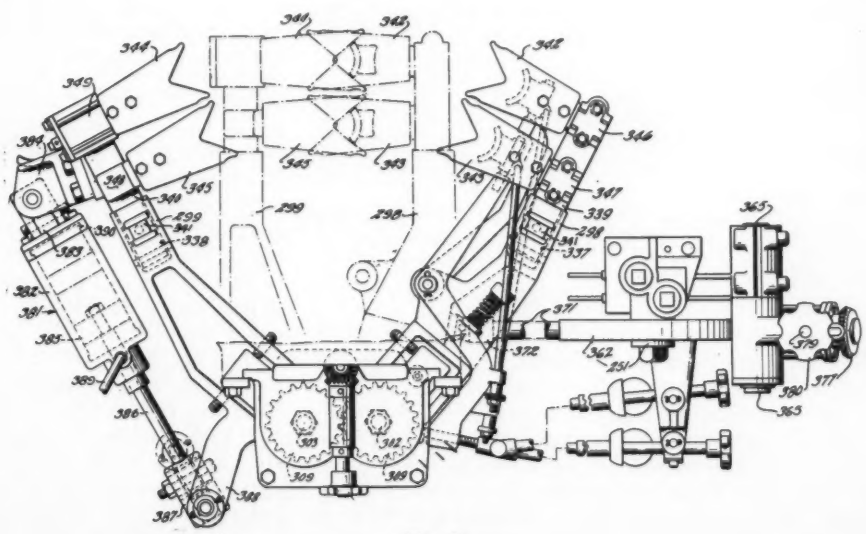


Fig. 2.

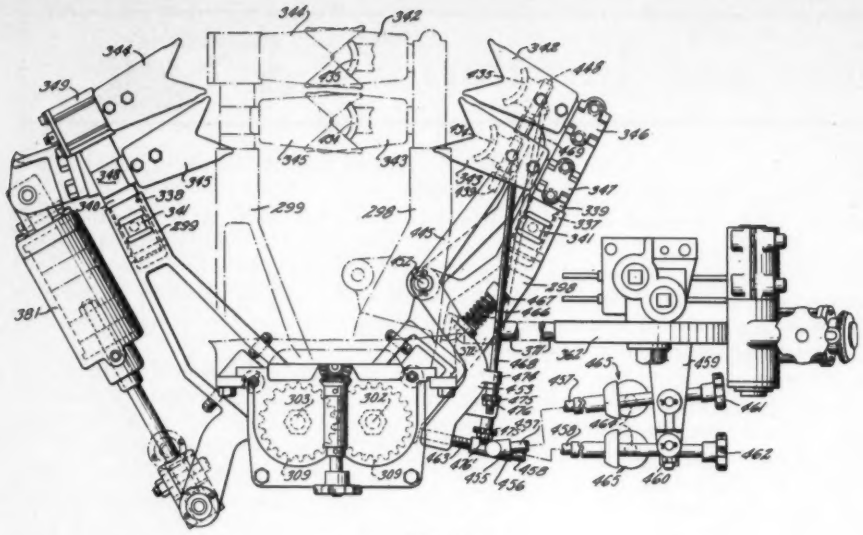


Fig. 3.

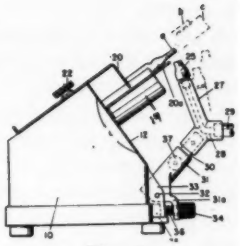


Fig. 4.

Serial No. 88,869, filed April 21, 1949, now Patent No. 2,654,184, for an improvement in glass feeding apparatus.

The shear mechanism comprises a right hand, horizontally disposed shear arm 298 and a cooperative left hand shear arm 299, as viewed in Fig. 3. The shear arms 298 and 299 are pivotally mounted on vertical shear posts or spindles 302 and 303, respectively. When swinging movement is imparted to one of the shear arms, the other will be correspondingly moved but in the opposite direction by reason of the action of co-engaging gears 309. The longitudinal adjustments of the end sections 339 and 340 in their shear arms provide adjustment of the points of cutting of the shear blades when they are closed as indicated by the dot-and-dash lines, these being predetermined to coincide with the axial lines of the respective orifices in the bottom of the feeder orifice ring. Also, this adjustment permits selective uses of the same shear mechanism with single and double orifice feeders. Thus, either the front or rear pair of shear blades could be positioned for use to sever glass which is provided in suspension from a single feed orifice.

The closing and opening movements of the shear arms are effected by suitable motion transmitting mechanism actuated by a shear cam 362 on the cam shaft 251. An air spring mechanism 381 is employed to cooperate with the cam 362 in controlling the opening and closing movements of the shear blades. The shears may be thrown out of operation during continued operation of the feeder by a mechanism.

The patent contains 5 claims and the following references were cited: 1,760,435, Peiler, May 27, 1930; 1,950,339, Barker, Jr., Mar. 6, 1934; and 2,472,560, Avery, June 7, 1949.

Sealing Apparatus. Fig. 4. Patent No. 2,680,331. Filed September 29, 1952. Issued June 8, 1954. One sheet of drawings. Frank J. Cozzoli.

This invention relates to the art of heat-sealing ampuls and tubes containing a pharmaceutical preparation in liquid or dry form, and has for a primary objective to produce, with minimum apparatus, strong and substantially uniform seals on containers of that kind. In using the apparatus, the ampul supporting shelf and the burner are adjusted to an approximate position for the seal and the burner is ignited. After the proper flame is obtained by conventional valves or Venturi mixer (not shown), the motor is turned on and the rolls 19 revolve.

In a normal position, such as illustrated in Fig. 4, the burner tip will direct its flame toward the tube to be sealed in a slightly upward and outward direction relative to the axis of the tube. Such an angular relation of the fire and the tube tends to direct the heat away from the contents in the body part of the tube which nevertheless concentrates the heat at the point where the seal is to be made. The letter a indicates a small ampul positioned for sealing, with the fire adjusted for forming a top seal. Letter b indicates the position of the top of an ampul of larger size, in which case the burner 25 will be adjusted to occupy a more outward position.

When a seal has been produced, the ampul may be lifted out of the channel between the rolls with the fingers and placed upon a shelf to cool.

The patent contains 4 claims and the following references were cited: 982,212, Koenig, Jan. 17, 1911; 1,242,837, Moberg, Oct. 29, 1917; 1,631,674, Favre, June 7, 1927; 1,948,560, Borneman, Feb. 27, 1934; and 2,367,495, Gray, Jan. 16, 1945.

Sealing Machine. Fig. 5. Patent No. 2,679,714. Filed March 21, 1952. Issued June 1, 1954. One sheet of drawings. Assigned to General Electric Company by Norman E. Kewley.

The cycle of operation of the sealing machine is initiated by the placing of the mount 4 upon the spindle 7 of one of the heads. The bulb 6 of the incandescent lamp is inserted into its proper position in the sealing head by passing the open neck 5 over the mount 4 and the upper end of the spindle 7, and by resting the bulbous portion of the bulb 7 upon the pads 14 of the bulb holder 15 on the upstanding posts 16 at opposite sides of spindle 7. Since it is desirable for the entire head 1 (spindle 7 and bulb holder 15) to be rotated while the bulb 6 is in operative relation to the sealing fires, a pulley 19 is located upon the lower end of the journal 18 of the base 17 for engagement with a moving belt (not shown). At certain of the work stations, a key 17′ and keyway are provided

in the base 17 and spindle 7 to cause them to turn as a unit.

The sealing operation performed by the machine is brought about in the same manner as in prior apparatus by burners (not shown) at various work stations about the turret 2. As the sealing operation progresses, the burners of the machine are assisted by a blast of air directed against the inside surface of the bulb neck 5 to cut off the excess neck portion or cullet below the flare 3.

The succeeding steps in the sealing operation, which complete the operation and which may, for instance, provide for the molding of the seal portion of the bulb 6, are carried on while the spindle 7 continues to be supported by the track 22 and, when need be, is vented and receives air from passages in the track 22 corresponding to passages 23 and 28.

The patent contains 3 claims and the following references were cited: 1,475,192, Marshall, Nov. 27, 1923; 1,942,042, Zimbler et al., Jan. 2, 1934; and 2,185,704, Donovan et al., Jan. 2, 1940.

Magnetic Centering Device for Butt Sealing Machines. Fig. 6. Patent No. 2,679,713. Filed September 22, 1951. Issued June 1, 1954. One sheet of drawings. Assigned to Westinghouse Electric Corporation by Walter J. Lytle.

This invention relates to sealing machines and, more particularly, to a magnetic centering device for a sealing machine spindle or head. The butt sealing machine is loaded by inserting an inverted bulb 60 into bulb cavity 58 of the head 14 with the bulb dome resting in the bottom pocket 59 of the cavity. The mount 62 having external portions 64 of leading-in conductors 66 preformed at the desired 45° angle from the mount axis is inserted into bulb 60 with the bends in the conductors 66 resting on the bulb neck. The external portions 64 are positioned and securely held on centering tips 78 by the magnetic force the permanent magnet tips 78 exert

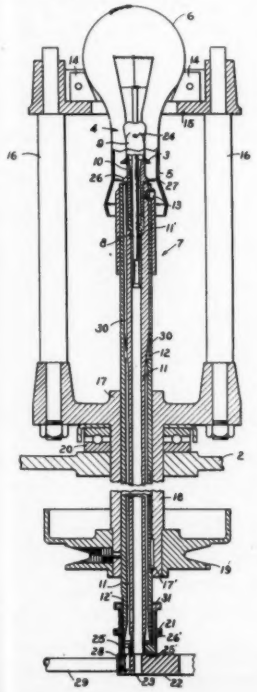


Fig. 5.

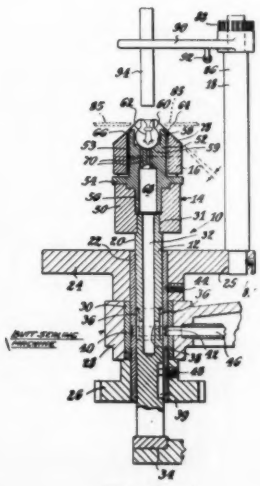


Fig. 6.

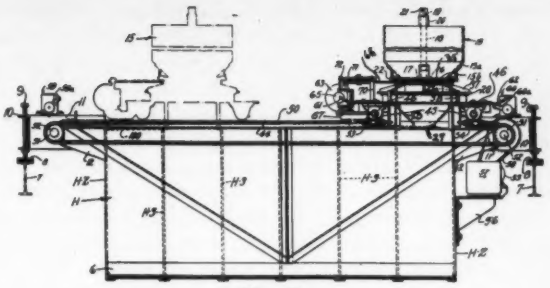


Fig. 7.

on the conductors 66, as well as the gravitational force exerted by the mount 62 on the bulb neck.

The bulb is securely aligned and held by a vacuum created by the vacuum line pumping through holes 70 and 68 in bulb adapter 52; pocket 32, holes 38 and groove 36 in shaft 20; holes 42 and groove 40 in bushing 22; and vacuum line 46. As the external portions 64 are unsupported between tips 78 and the bulb neck, the action of the positioning finger in station 3 (not shown) combined with the magnetic force causes a sag and a resultant spring action in the unsupported length, thereby firmly pressing the bulb 60 against the bottom pocket 59 of bulb cavity 58 and maintaining the bulb 60 and mount 62 in this position during the remainder of the sealing operation.

It will be seen from the foregoing description that a magnetic centering device 16 for a sealing head assembly 10 employing the force of magnetism in addition to the force of gravity to center the mount relative to the bulb during the sealing operation has been achieved. This magnetic centering device has a permanent magnet centering tip 78 located symmetrically at the sides of the bulb adapter 52 of the sealing head 14.

The patent contains 3 claims and the following references were cited: 1,716,167, Grogan, June 4, 1929; and 2,549,359, Bakanau, Apr. 17, 1951.

Furnaces

Apparatus For and Method of Filling Glass Batch Charger Hoppers. Fig. 7. Patent No. 2,679,324. Filed January 26, 1948. Issued May 25, 1954. Two sheets of drawings. Assigned to Emhart Manufacturing Company by Madison M. Cannon, Jr.

This invention relates to improvements in apparatus for and methods of supplying glass batch to glass batch charger hoppers. An object of the invention is to prevent the segregation of fine and coarse particles of batch as the batch hopper is filled by discharge from a batch bucket.

In moving along the top of the hopper, batch will descend from the discharge opening 27 of the rotator funnel into the hopper to fill the latter to the bottom edge of the discharge end of the rotator funnel and, in use, to keep the hopper filled to this approximate level. Rotation of the batch bucket and the hopper funnel as a unit is employed to nullify such segregation by grain size of the constituents deposited in the bucket that usually exists. Such rotation is effected, as seen in Fig. 7, by a mechanism comprising a motor 63 driving a small sprocket wheel 64 through a speed reduction unit 65, the small sprocket 64 (not shown) in turn driving a chain 66 which is trained about and drives the relatively large ring sprocket 35 on the rotator funnel 23. Since the trans-

verse dimension or diameter of the effective discharge orifice of the batch bucket, which is the discharge opening 27 of the intervening rotator funnel, is only slightly less than the internal width of the hopper, the hopper may be filled without sufficient lateral flow of the batch as it settles to produce harmful segregation.

The patent contains two claims and the following references were cited: 522, 705, Chandler, July 10, 1894; 910,233, Roberts, Jan. 19, 1909; 1,824,483, Hubmann et al., Sept. 22, 1931; 1,864,711, Buettell, June 28, 1932; 2,219,226, Gerber, Oct. 22, 1940; 2,238,200, Willeke, Apr. 15, 1941; 2,306,510, Trickey, Dec. 29, 1942; 2,420,653, Clark, May 20, 1947; and 648,204, Germany, July 24, 1937.

Glass Compositions

Glass Composition for Glass Fibers. Patent No. 2,681,289. Filed March 4, 1950. Issued June 15, 1954. One sheet of drawings (none reproduced). Assigned to Gustin-Bacon Manufacturing Company by Lorenzo D. Moore.

The important object of the present invention is to provide, as a raw material for fiber attenuation, a glass which is easy to melt and fine at temperatures below those which would be injurious to the furnace or bushing, and which is free of stones, bubbles and stringy portions when at the proper temperature for fiber attenuation. The formulation of a glass composition from the elements, silicon dioxide, aluminum oxide, calcium oxide and boron oxide is shown in the following ranges:

	Per cent
SiO_2	46-52
Al_2O_3	14-18
CaO	18-24
B_2O_3	9-14

These ranges were determined by compounding many batches of glass having their components in the various proportions and determining their fining and working properties. By decreasing the silica content of the composition, as compared to former compositions, in favor of an increase in the alkali earth, calcium oxide, and by increasing the proportion of boron oxide which is substituted for the alkali oxide fluxes, there was produced a glass having excellent properties of corrosion resistance. Then, by maintaining the boron oxide content above 9% and never allowing the aluminum oxide to be present in proportions greater than 18%, it was found that the melting and fining and the viscosity-temperature relationship of the product was materially improved.

The patent contains 4 claims and the following references were listed: 2,334,961, Schoenlaub, Nov. 23, 1943; 2,571,074, Tiede et al., Oct. 9, 1951; and 520,247, Great Britain, 1940.

Glass Wool and Fiber

Woven Glass Electrical Insulating Sheet. Patent No. 2,679,677. Filed October 30, 1951. Issued June 1, 1954. One sheet of drawings (none reproduced). Assigned to General Electric Company by Eugene L. Crandall.

This invention relates to an improved type of electrical insulating sheet material having a base of a woven glass fabric wherein, while an individual glass fiber yarn will not permit elongation, the weaving is such that the fabric will exhibit a significant longitudinal elongation. The preferred weaving is a leno or gauze weave wherein the longitudinal or warp yarns are loosely twisted, so that when the fabric is longitudinally stretched the twist is tightened to give a certain degree of over-all elongation. The new material is designated as "varnished glass". The varnished glass tape is made from a base glass fabric having a leno or gauze weave pattern. The glass fabric is then coated and/or impregnated with an electrical insulating varnish to fill in all the gaps between the yarns of glass fibers providing a continuous sheet of varnished glass.

The patent contains 3 claims and the following references were cited: 240,772, Schinneller, Apr. 26, 1881; 702,725, Hammesfahr, June 12, 1902; 2,133,183, Baird et al., Oct. 11, 1938; 2,209,850, Shand et al., July 30, 1940; 2,360,245, McFarlane, Oct. 10, 1944; and 260,136, Great Britain, Oct. 28, 1926.

Sheet and Plate Glass

Method and Apparatus for Bending and Tempering Sheets of Glass. Fig. 8. Patent No. 2,680,936. Filed August 24, 1949. Issued June 15, 1954. Five sheets of drawings. Assigned to Pilkington Brothers Limited by Augustus W. Grotefeld.

This invention relates to the art of bending and tempering sheets of glass. The tempering means illustrated in Fig. 8 include two series of uniformly spaced tubular fingers, 22 and 23, each connected at one end to a mutual header 24, and provided with a pipe 25 attached by a flexible fluid connection 26 to a source of quenching fluid supply (not shown) whereby quenching fluid is supplied to the two series of tubular fingers. The fingers 22 and 23 are sealed at the tips and perforated along their length to form jets so arranged that jets projected from one series of fingers are projected towards the jets emanating from the fingers in the other series. Thus the tempering means comprises opposed tempering grids, each grid including a plurality of parallel tubes apertured uniformly along their length to provide quenching jets which are directed to the two surfaces of the glass when interposed between the grids, and the width of the glass engaging means 10 being related to the spacing of the fingers in each grid so as to readily permit relative movement between the fingers and the rods 13 of the ancillary supports.

The two series of fingers 22, 23 are arranged in arcs which correspond in curvature to the surface of the beds and the apertures in the tubes are arranged so that the jets are substantially directed in a direction which is normal to the surface on which the jets impinge. The header 24 is mounted on vertical brackets 27, one to-

(*Continued on page* 636)

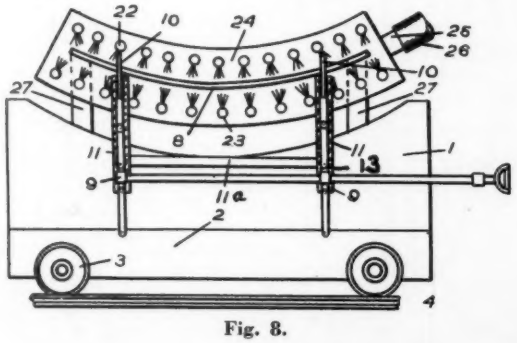


Fig. 8.

Research Digest

Heating Up Glass Melting Furnaces After Rebuilding

The knowledge that silica brick are very sensitive to heat shock has been extremely costly to the glass industry because there is only a half truth in the statement. Playing on the safe side, many glass plant operators have resorted to unnecessarily slow heating rates to bring furnaces up to operating temperature. In certain temperature ranges, silica brick are but slightly affected by temperature change, and only in the low temperature range is silica brick sensitive to rapid heating. About 75% of the expansion of a silica brick occurs below 600°F. Between 600° and 800°F. an additional 10% of the expansion takes place, with the final 15% taking place between 1300° and 1400°F. This demonstrates the drastic necessity for controlled heating up from initial temperatures to 600°F. and the almost complete insensitivity of the silica brick to the heating rate above 1200°F.

Recently, Kraner and Jewart demonstrated that for silica crowns 125°F. per hour from 100° to 600°F., 150°F. per hour from 600° to 1200°F. and 300°F. per hour from 1200° to working temperature was a safe heating rate in open hearth furnaces. It, therefore, is apparent that the silica brick as used in glass furnace crowns is no deterrent for any rate of heat-up if designed properly. The heat-up rate depends more upon how fast the refractories in bottom, sidewalls and superstructures can be heated. Since this portion of the furnace is rather important, heat-up schedules should be designed to safely heat up refractories in these areas. L. F. Robertson in the August 1954 issue of the *Bulletin of the American Ceramic Society* describes in detail such a procedure.

The general practice is to bring the furnace to operating temperature empty and then fill. The actual heat-up is done by using a burner made of 3-inch pipe which is inserted through each port and made long enough to extend about three feet beyond the inside of the blocks. To this pipe is attached a high-pressure gas inspirator. A flexible piece of hose connects the inspirator to the gas header, allowing the burners to be withdrawn as the fuel rate is increased.

Fires are lit on all ports and when first started, the air adjustment on the inspirators are set so as to have a rather rich mixture and just enough gas turned on to keep the flame lit, which is sufficient for a gradual rise in crown temperature for some time. The gases are allowed to escape through the expansion joints in the crown. The fires can be lit before the checker rebuild work is completed. Once the checkers are set and the regenerator doors bricked up, the stack damper is raised slightly. The air valves are set "on center" so that the hot gases are pulled back over the burners and down through the checker chambers. One or two days before these furnace fires are lit, a fire is placed in the stack as an aid to starting the draft. By the time the expansion joints in the roof are closed, the draft is pulling warm gases down through the regenerator chambers, thoroughly imparting heat to the checkers. The heat-up rate is controlled manually by bringing the crown temperature to conform with the heat-up curve, by increasing gas flow through the inspirators. As the gas is increased, the burner pipes are withdrawn so that the lengthening of the flame does not impinge upon the bottom blocks. The gas inspirators are designed so that only 70% of the air required for combustion can be drawn through the inspirator. The remaining 30% comes through by infiltration, through openings in peepholes, joints, etc. This prevents the burners from getting out of hand and insures a soft fire at all times and minimizes the chances of excess temperature locally at the burner.

The rate of heat-up is set up so that the lowest rate of temperature increase is applied during the range of the greatest expansion of silica brick. As the expansion decreases, the rate of temperature rise is increased. A day and a half is taken to get above the critical range of 600°F. for the silica, conforming to a heating rate of 16.6°F. per hour, well under the safe heating rate of 125°F. per hour as determined by Kraner and Jewart. During this period, the heat-up men give special attention to the handling of the buckstay rods to control the rise of the cap. After the second day, it is only necessary to check the top rods periodically, with attention given wholly to the bottom block and sidewall blackjack bolts.

Once above 800°F., the heat gain is approximately 55°F. per hour and this has proven to be a safe one for bottom, sidewall and superstructure refractories. At the start of the third day, the air valve is moved to firing position and the regular low pressure side burners turned on leaving the high-pressure burners to act as pilot lights. The furnace is reversed every five minutes for two hours so as to prevent spalling of the checker work. When 1400°F. is reached, the pilot light burners are withdrawn. The furnace is then reversed on ten-minute cycles until full fuel rate is attained and then reversed on 15-minute cycles thereafter. Full fuel rate for the furnace described is about 25,000 cu. ft. per hour, increasing to 30,000 cu. ft. per hour when filling in. The furnace pressure is carried lower than normal in order to enable the relatively cold checkers and stack to handle the products of combustion, from the time when side firing is first introduced and gradually brought to normal when the furnace is at operating temperature. When an optical temperature of 2300°F. is reached, filling is started with factory cullet and continued until the melting end bottom is covered with approximately 12 inches of glass and is sufficient for the batch to float away. A mixture of 50% cullet and 50% batch is then introduced to bring to within six inches of the working level and the regular batch is introduced to bring to working level. In this particular furnace, the total time from initial heat-up to draining prior to production was 8 days, or about 50% of the time that was originally normal practice.

Short heat-up periods offer several advantages over the longer heat-up periods. Among them are: (1) increas-

(*Continued on page* 634)

L. ALBERT & SON ACQUIRES CAMBRIDGE GLASS

It has been announced that Sydney L. Albert, nationally-known Akron industrialist, has acquired 100% of the stock of the fifty-year old Cambridge Glass Company of Cambridge, Ohio, for an undisclosed sum. Cambridge Glass is one of the few producers of fine handmade, blown glass and crystal.

The acquiring interests are represented by Sydney L. Albert of Akron, Ohio, President of L. Albert & Son, suppliers of rubber mill machinery and plastic machinery, maintaining plants and warehouses in Trenton, New Jersey, Akron, Ohio, Chicago, Los Angeles and Brantford, Ontario, Canada. Albert & Son, now in its 65th year of operation, is the largest of its kind and has significantly contributed to the ever-growing importance of the machinery industry in this country during, as well as since the wars.

Founded in 1901, the Cambridge Glass Company produced its first piece of glass in May, 1902, and has since then steadily increased its line of stem and flat glassware. A leader in its industry group, Cambridge Glass has for many years led a campaign to obtain Federal relief against imported wares which, because of low cost labor, have reduced the home market for American made merchandise. Recent statistics show that 64% of the American market has been saturated with imported glass products. Further difficulties have been caused in the industry because of the high cost of domestic labor, further aggravated by the fact that the members of the handmade glass industry group are forced to bargain with the Union on an industry-wide basis.

Recent officers of The Cambridge Glass Company, W. L. Orme, Sr., President, W. L. Orme, Jr., Vice President in charge of Production, Arthur B. Orme, Vice President, W. C. Orme, Treasurer, and W. C. McCartney, Secretary, have resigned. New officers of the company are William McCormish, Chicago, Illinois, President; Ralph Leonard, Akron, Ohio, Executive Vice President; Arthur B. Orme, Vice President in charge of Sales; W. L. Orme, Jr., Vice President in charge of Production; Arthur K. Rothschild, Trenton, New Jersey, Treasurer; William C. Orme, Assistant Treasurer; Ben Holub, Akron, Ohio, Attorney and Secretary; and Estelle B. Albert, Akron, Ohio, Assistant Secretary.

The acquisition of the Cambridge Glass Company brings the number of plants under Albert's control to twenty-six. Among these are The Akron Gear & Engineering Company of Akron, Ohio; The New Bremen Rubber Company of New Bremen, Ohio; The Lake City Malleable, Inc. of Cleveland, Columbus and Ashtabula, Ohio; and Albert-Harris Inc. of Akron, Ohio and Lubbock, Texas. Earlier this year Albert bought the fifty-three year old Browning Crane & Shovel Company of Cleveland, Ohio, one of the oldest and best reputed manufacturers of rubber-mounted and locomotive cranes.

The new management is studying cost reducing possibilities and has entered into negotiations with its Union to effect substantial cost reductions. A spokesman for the company indicated that the new management will steer a straight course and place all its energies and emphasis on producing and selling fine glassware rather than waste its energies worrying about imports and competition.

A. W. WISHART NAMED TO HEAD KNOX GLASS BOTTLE COMPANY

V. T. Norton, Chairman of the Board of Directors of Knox Glass Bottle Company, has announced the appointment of Arthur W. Wishart as President of that company and its subsidiaries.

Mr. Wishart has a broad background of experience in the glass industry, having served as vice president and general manager of a number of glass manufacturing concerns in this country and abroad. He joins Knox from the Westinghouse Electric Corporation's Glass Manufacturing Division, which he organized and managed.

A graduate of the University of Minnesota, Mr. Wishart formerly resided in Fairmont, West Virginia. He will now be located in Knox, Pa.

BOOK REVIEW

Glass Melting Tank Furnaces

By Rudolph Gunther

This newest book on glass tank furnaces covers all of the major and minor factors pertaining to glass tanks, their construction, operation and theory. In the 200 pages of text, the author devotes about 25 pages to brief descriptions of glass furnace construction and operation. While coverage has been given to the many points of these two phases of the subject, in several instances it is felt a more detailed treatment of important factors would have been desirable.

In the balance of the book, the author has attempted to cover a great many individual details relating to the process, building and calculation. For this reason, it would seem that the book would be of primary value to students and those desiring a general understanding of tank furnaces and glass melting.

Throughout the text, over 100 different items are mentioned and discussed. A considerable number of charts, tables and illustrations are presented which have tended to reduce description of the individual items in a book of this size.

Broadly, the subject of glass tank furnaces is covered very well, making one aware of the numerous and diverse factors to be considered in designing and operating glass furnaces. It may be assumed that is the original intent of this small book. In this manner, it will fill a need and will also serve as a prompter for those who wish to delve deeper into various phases of the subject.

Published by Deutschen Glastechnischen Gesellschaft, Untermainkai 12, Frankfort (Main) 1, Germany; 250 pages.

Charles Cala
Bausch & Lomb Optical Co.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during August 1954 was as follows: *Flat Glass:* Preliminary employment was reported to be 24,700, a drop of 1.2 per cent from the previous month's adjusted 25,000. *Glass and Glassware, Pressed and Blown:* 77,300 persons was the preliminary figure reported for August. This is 5 per cent higher than the adjusted 73,600 shown for July. *Glass Products Made of Purchased Glass:* The August preliminary employment figure is 13,700, or 6.2 per cent higher than the adjusted 12,900 for July.

Payrolls during August 1954 were as follows: *Flat Glass:* A drop of 2.7 per cent is shown in the preliminary $10,306,240 when compared with July's adjusted $10,599,333. *Glass and Glassware, Pressed and Blown:* A preliminary $23,514,660 has been reported for August 1954, representing a rise of 6 per cent over July's adjusted $22,165,867. *Glass Products Made of Purchased Glass:* An increase of 9.1 per cent is shown in the preliminary $3,657,580 as compared with July's adjusted payrolls of $3,351,205.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers	September, 1954
Foods	1,511,000
Medicinal & Health Supplies	1,142,000
Chemicals, Household & Industrial	848,000
Beverages, Returnable	285,000
Beverages, Non-returnable	58,000
Beer, Returnable	95,000
Beer, Non-returnable	582,000
Liquors	794,000
Wines	371,000
Toiletries & Cosmetics	689,000
Sub-total (Narrow)	6,375,000
Wide Mouth Containers	
Foods	*3,069,000
Dairy Products	303,000
Medicinal & Health Supplies	408,000
Chemicals, Household & Industrial	164,000
Toiletries & Cosmetics	173,000
Packers' Tumblers	142,000
Sub-total (Wide)	4,259,000
Total Domestic	10,634,000
Export Shipments	219,000
TOTAL SHIPMENTS	10,853,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production September 1954	Stocks September 1954
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,777,000	4,306,000
	Wide Mouth	*3,651,000	*4,106,000
Dairy Products		274,000	273,000
Beverages, Returnable		258,000	1,359,000
Beverages, Non-returnable		40,000	215,000
Beer, Returnable		115,000	455,000
Beer, Non-returnable		472,000	797,000
Liquors		778,000	1,118,000
Wines		376,000	476,000
TOTAL		9,883,000	13,299,000

* This figure includes Fruit Jars and Jelly Glasses.

Glass container production during September 1954, based on figures released by the Bureau of Census, fell off to reach 9,883,000 gross. Compared with the 11,386,000 gross produced during August, a drop of 13.2 per cent is shown. Production during September 1953 was 10,214,000 gross, or 3.2 per cent higher than September this year. Glass container production at the end of the three-quarter period of 1954 has reached a total of 96,071,616 gross. This is 2.8 per cent higher than the 93,421,772 gross produced during the first nine months of 1953.

Shipments of glass containers during September 1954 also dropped off to reach 10,853,000 gross. This is 4.6 per cent below the 11,386,000 gross shipped during August. During September 1953, shipments were 10,803,000 gross, or .4 per cent less than September this year. At the close of the first nine months of 1954, a total of 93,251,195 gross have been shipped by glass container manufacturers. This is 1.1 per cent ahead of the 92,171,302 gross shipped during the same period in 1953.

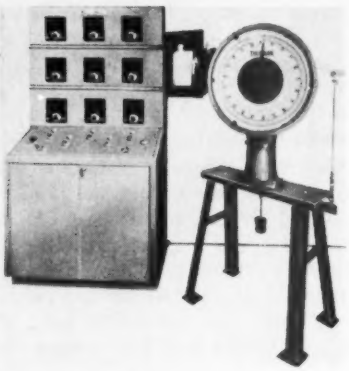
Stocks on hand at the end of September 1954 were 13,299,000 gross. This is 7.3 per cent less than the 14,360,000 gross on hand at the end of July and 26.3 per cent higher than the 10,527,000 gross on hand at the end of September 1953.

Automatic tumbler production during August 1954 was 5,131,368 dozens. This represents a rise of 30.1 per cent over the previous month's 3,943,087 dozens. During August 1953, production was 5,704,610 dozens. Shipments also took a rise and were 5,213,395 dozens. This is 12.9 per cent above July shipments of 4,615,737 dozens. Shipments during August 1953 were 5,388,554 dozens. Stocks on hand during August fell 1.1 per cent to 8,651,645 dozens from the previous month's 8,751,362 dozens. Stocks at the end of August 1953 were 10,107,240 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware also turned upward during August to reach 2,965,741 dozens. This is 13.8 per cent higher than July's sales of 2,605,881 dozens. During August 1953, sales were 3,252,413 dozens. At the end of the 12-month period ending August 1954, sales had reached a total of 37,184,498 dozens. This is 10.2 per cent less than the 41,432,840 dozens sold during the same period in 1953.

• Charles D. LaFollette, Vice President, Treasurer and Director of Sales for Corning Glass Works, addressed members of the National Industrial Conference Board at the opening session of the group's Annual Marketing Conference.

New Equipment and Supplies



ELECTRONIC BATCHING SYSTEM

Thurman Machine Company, Scale Division, 156 N. Fifth Street, Columbus, Ohio, is manufacturing a new simplified, compact and versatile electronic batching system for the continuous process industries such as the glass industry, chemical plants, ceramics, etc.

Providing more rapid weighing of all material for accurate batching, the new Thurma-tronic electronic batching system is adaptable to either accumulative or consecutive weighing. Controls may be set to weigh one batch or for completely automatic continuous batching. In addition, controls may also be set to weigh any specific number of batches. Thus, all materials in any formula can be automatically and accurately weighed and transferred from storage bins to mixers and processing machinery without costly handling or time consuming delays.

The electronic design of the system is unlimited in the number of materials that may be batched in one formula. Also, any formula requiring change by the batching operation can be quickly and easily reset to meet production requirements.

FRONT LOADING KILNS

The O. Hommel Company, Pittsburgh 30, Pa., has introduced a new line of front loading kilns made of cold rolled steel and which come in low firing and high firing models.

The low firing kilns can be safely operated at 2050°F., while the high firing kilns will safely operate as high as cone 2300°F. The design of these kilns feature lifelong, scientifically engineered pilots and switches. The routed walls carrying the elements permit free and easy passage of heat to assure top quality firing.

BIN LEVEL INDICATOR

The Bin-Dicator Company, 13946036 Kercheval, Detroit 15, Michigan, has announced a new model Bin-Dicator bin level indicator incorporating a built-in bull's eye signal light for use in installations requiring a signal which can readily be seen by an operator.

The new model has been designated Model "AL" Special Bin-Dicator and is a complete, visual signal system in one package. It comes completely assembled and ready for connection to the user's power source. A toggle switch is provided so that the signal light may be shut off if desired.

PHOTOSWITCH PHOTOELECTRIC PYROMETER

Photoswitch Division, Electronics Corporation of America, Dept. P204, 77 Broadway, Cambridge 42, Mass., has announced the development of a photoelectric pyrometer for industrial use which makes possible the precise monitoring and control of the temperature of hot materials.

The control operates from the amount of infrared radiation emitted by the hot object, and since radiation increases proportionally with the temperature, a constant indication is given of the heat of the material being scanned. Through a fast-acting relay, the heat applied to the material can be closely controlled at any point throughout the range of the set. Since no part of the equipment touches the hot object, the system is ideal for measuring the temperature of objects that are moving, or are surrounded by induction heating coils, or are in any way difficult to measure by conventional methods.

CARY RECORDING SPECTROPHOTOMETER

Applied Physics Corporation, Pasadena, California, is manufacturing a new Cary recording spectrophotometer with wavelength range extended to include near infrared and with increased photometric accuracy.

The new Model 14 incorporates a newly designed double monochromator and flicker beam photometric system. It automatically records absorption spectra in the wavelength region of 2000 A to 2.6 microns with good resolving power and high photometric accuracy. It records in absorbance and on a linear wavelength scale.

The Model 14 ultilizes a fused silica prism in series with a 600-line per millimeter echelette grating. This combination of dispersing elements provides the high resolving power and low temperature coefficient which are available with the grating at long wavelengths and at the same time retains the high optical efficiency and low scattered light characteristic of the prism monochromator. Interchangeable light sources for the instrument are a hydrogen lamp for the ultraviolet region and tungsten lamps for the visible and near infrared regions.

DIFFERENTIAL TRANSFORMER AMPLIFIER

Daytronic Corporation, 216 S. Main Street, Dayton 2, Ohio, has developed a new Model 400 differential transformer amplifier for the study and accurate measurement of static, transient or higher frequency oscillatory physical phenomena, including force, pressure, stress, strain, acceleration and displacement.

The unit, used in conjunction with available differential transformer transducers, includes a carrier oscillator, demodulator and all circuits necessary to provide an output suitable for display or photographing on a cathode ray oscillograph. Low impedance output for galvanometer oscillographs is optionally available.

NEW MASONRY SAW

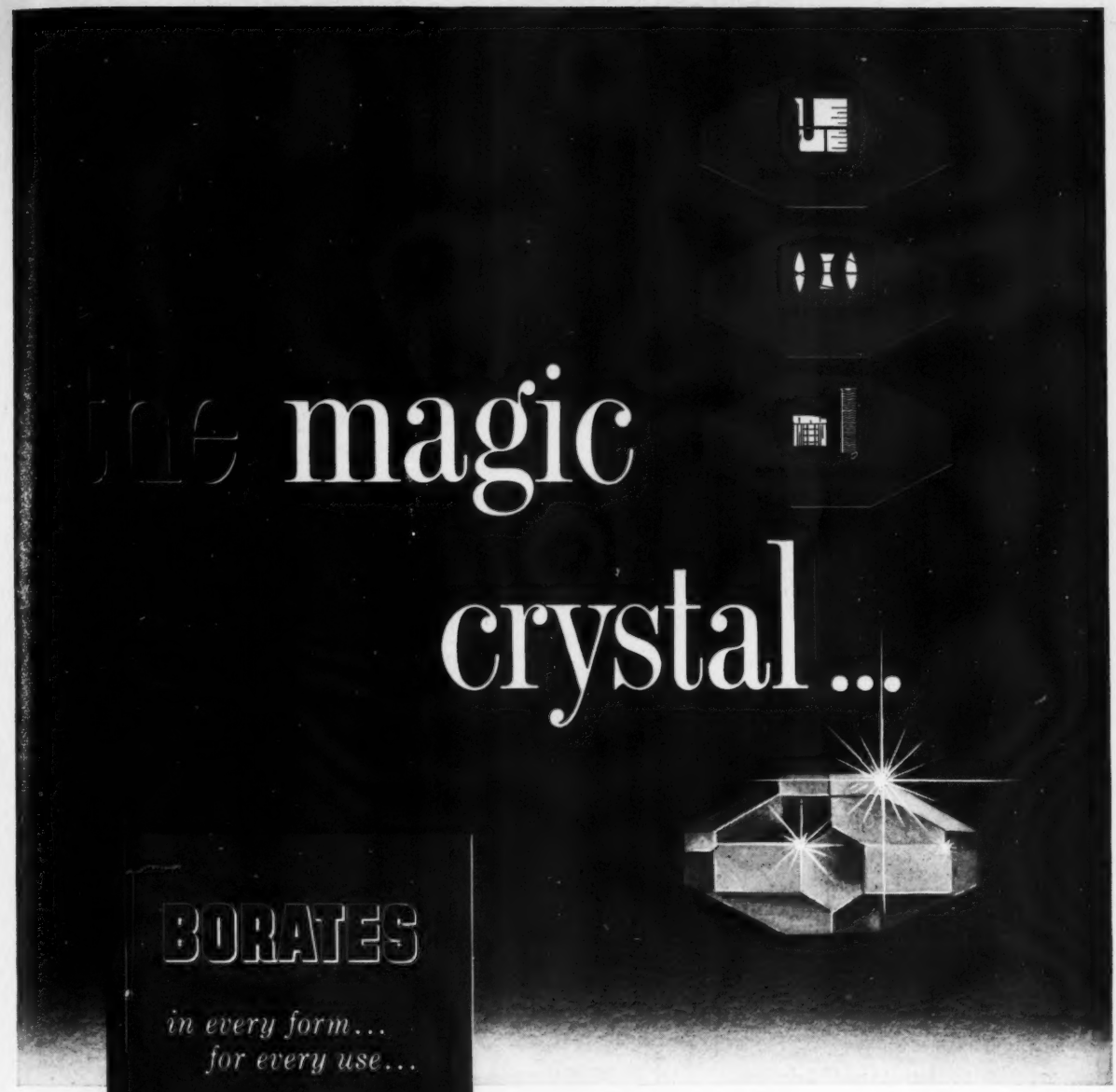
Felker Manufacturing Company, Torrance, California, has designed a new Di-Met masonry saw for use on all masonry materials. The new cut-off saw operates either wet or dry and uses either diamond abrasive blades or ordinary abrasive cut-off wheels. It performs all types of operations, such as step cutting, through cutting, skew cutting and angle cutting, with new ease and speed.

A feature of the saw is its speed of adjustment. All adjustments are made from the operating position. The head rises to any necessary height on two telescoping standards located at the rear of the machine. It is mechanically lifted from the front by a series of pumps on the foot pedal. Height adjustment is sufficiently great to permit the arbor to remain in a horizontal position regardless of work size. The arbor can be tilted however, and rigidly locked at the desired angle.

CATALOGS RECEIVED

Fischer & Porter Company, 172 Jacksonville Road, Hatboro, Pa., has made available a new 12-page catalog with illustrations, descriptions and basic specifications of its complete line of process instrumentation.

Instrumentation for measuring and controlling process variables, includes: variable-area and variable-head flow meters; pressure instruments; temperature instruments; liquid level instruments; density and specific gravity measuring instruments; viscosity and consistency instruments; electric, pneumatic and electronic transmitting, recording and controlling instruments with alarms and integrators; and air-operated control valves in various models and construction materials.



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AMERICAN POTASH MAKES RESEARCH APPOINTMENT

Harold Mazza, research process engineer for American Potash & Chemical Corporation, has been appointed Assistant Director of Research for the company, according to an announcement by D. S. Dinsmoor, Vice President in charge of Research and Development.

Mr. Mazza, who joined American Potash & Chemical in 1929 as a sampler in the control laboratory, will direct the activities of the New Products Division at the Trona Research Laboratory.

Joining the firm shortly after his graduation from the University of California with a B.A. degree in chemistry, he has done extensive work in both production and research departments.

FOOTE MINERAL DECLARES 3-FOR-1 STOCK SPLIT

The directors of Foote Mineral Company have declared a 3-for-1 split of the presently outstanding common stock of the company to shareholders of record at the close of business November 10, 1954. This action is subject to approval by shareholders of a proposed amendment to the Articles of Incorporation of the company. If passed by the shareholders, it would become effective upon approval by the state authorities.

Adoption of the proposed amendment would result in the reduction of the present par value of the common stock from $2.50 per share to $1.00 per share, and an increase in the authorized number of common shares from 1,000,000 to 2,500,000.

BRITISH SAFETY GLASS INDUSTRY AT PEAK

The tremendous expansion of the automobile industry in Great Britain and a very high level of exports is creating continued peak business for the safety glass industry. The British problem is now to expand fast enough to meet increased demand and to diversify production sufficiently to supply all the variations of materials required throughout the world for automobile production.

Speaking at the 33rd annual general meeting of Triplex Safety Glass Company, Ltd., Sir Graham Cunningham K.B.E. said that he must emphasize that it is not merely making glasses with the varying curves and bends that is the sole difficulty. The problem is making *safety* glass with these curves and bends. He went on to relate that his firm not only had to erect a plant for the production of these curved glasses in toughened safety glass for the home and export market, but also for cars fitted with laminated safety glass windscreens for export to Canada and America and some continental countries. Customers require some safety glass laminated and some toughened, involving two different processes and plants. Sir Cunningham reported that of the constantly increasing automobile production in Britain, over 50 per cent of the total is exported.

• The National Academy of Sciences, National Research Council, is now compiling the 10th Edition of "Industrial Research Laboratories of the United States", a directory of American industries and businesses which maintain scientific research and development facilities.

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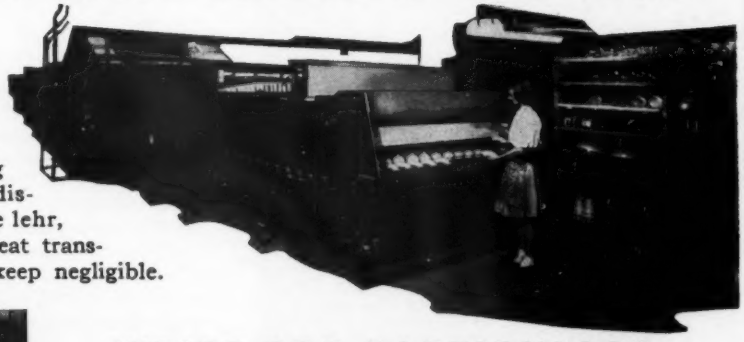
to handle LIGHT and HEAVY DECORATED GLASSWARE



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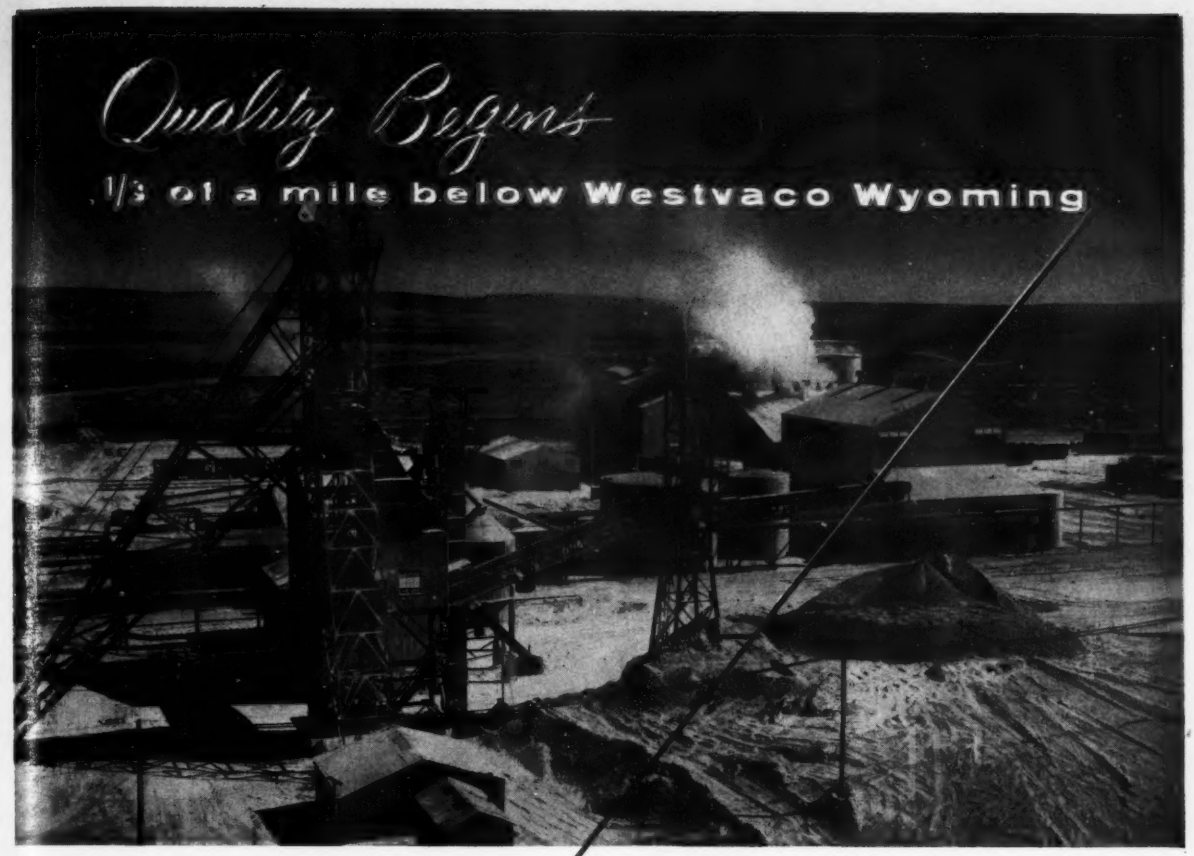

Nature deposited millions of tons of unbelievably pure trona (sodium sesquicarbonate) below our Westvaco, Wyoming plant. We mine this unique mineral and refine it by patented processes into WESTVACO Soda Ash — an excellent product that equals or exceeds traditional synthetic process ash in both chemical and physical properties.

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Currently, our economic shipping limits are from the Mississippi to the Panhandle to the Pacific . . . with some deviations here and there due to the peculiarities of freight rates. If you are located in this area we will be glad to furnish technical data, working samples and prices on the grade you can best use.

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GUARDING VS. DISCIPLINE

(*Continued from page* 610)

fresh paint so that curious human beings will not touch it. So, since the turn of the century, guards against accidents have become an integral part of every machine's design. This crusade is still the backbone of all industrial accident programs. Today, reduction of accidents in industry has been greater than in the home or on the highway. Safeguards developed for industry have now been incorporated into the home."

Picking up where his affirmative side team mate concluded, Mr. Mateer said, "Fifth, after housekeeping, is preventive maintenance. It's always proper to say, 'a stitch in time saves nine'. Consideration must be given to every machine to incorporate phases in it that will prevent accidents. In this, the engineering department will cooperate with the safety department. In our own plants, the power transmission, the large drive shaft leading to machinery, is completely covered, and even its maintenance such as oiling and greasing is automatic."

Another safeguard, Mr. Mateer pointed out, is the trend to mechanized handling of raw materials. Also, government regulations specify that certain safety factors must be maintained.

"On certain types of jobs, protective equipment such as goggles and face masks are a *must* to prevent acids splashing into the face, or flashes from welding, or from poisonous dust. Standards of guarding have been set and are being followed. Accidents cannot be avoided without use of these personal guards. Further reduction of accidents will stem from the fact that more workers are *guarded!*"

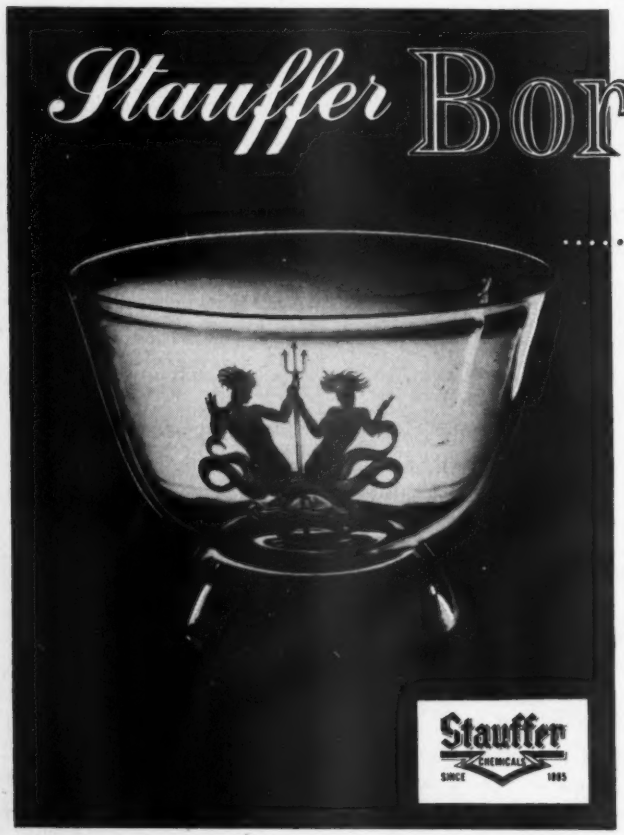
The final argument on the negative side, presented by Mr. Bauer, was that "only *education* makes these guards effective. They are effective—if the employee is cooperative and has the desire to *use* them."

The best help offered to supervisors by the safety director, in Mr. Bauer's opinion, is to see that four points in the employee's work are carried out: (1) Training, or (2) job instruction; (3) Tryout at the job under the supervision of the foreman; (4) Let the man go on his own, with the satisfaction to all that he knows what the hazards are and will do his best to not fall victim to them. Also, he should know which person to contact should he run into trouble.

"How could mechanical guards keep this man from getting hurt, as inexperienced as he is? Suppose he had tried to fix his own breakdown on his machine? He must be trained, trained and trained. These points must be driven home at supervisors' meetings, and many visual aids, or 'gimmicks', must be used to stress the importance."

Especially important, Mr. Bauer feels, is that supervisors must regard their workers with a generous portion of human relations, to think of them as human beings and not machines to be driven ruthlessly and expected to hold up without accident. "We must tell them to lead, not push. The more they understand human relations, the fewer accidents they will have in their shop."

The rebuttal period was open to the assemblage, whose arguments were divided equally between pro and con. In essence, all agreed that training (discipline) and guarding go hand in hand, and the moderator of the debate concluded that it was a very even "draw".



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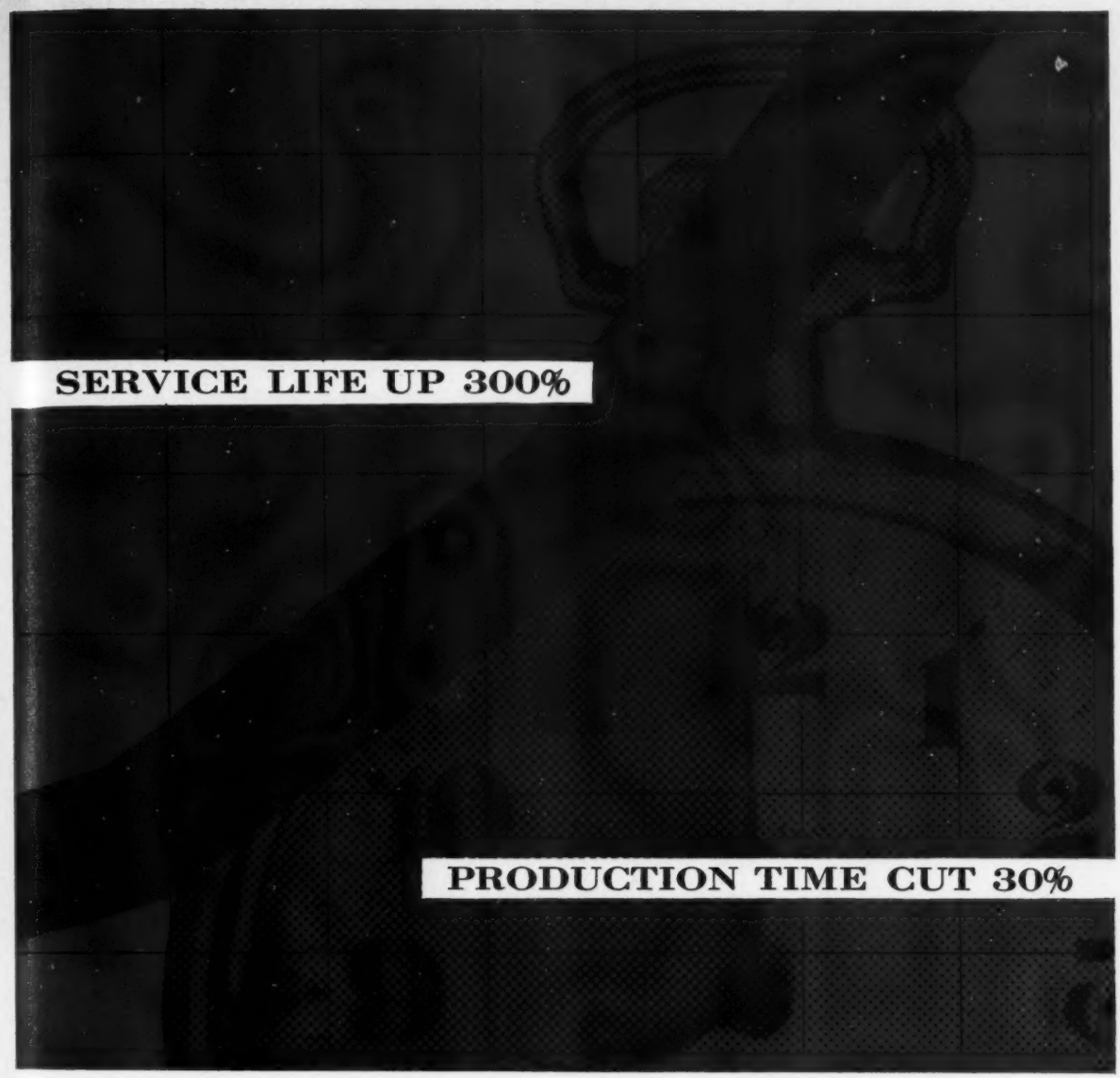

How ceramic engineers and Alcoa Aluminas are making money for grinding mill operators

A grinding mill operator, like any other manufacturer, knows that the way to make more money is to turn out more product without taking more time to do it. That means he's got to improve the efficiency of his grinding equipment, and that's not always easy.

In 1949, ceramic engineers at Coors Porcelain Company tackled the problem. Working with ALCOA Alumina because of its unmatched qualities of toughness and abrasion resistance, they now have the answer . . . a new high-density alumina mill lining and grinding medium.

In an actual operational test lasting 17,470 hours, the new media cut grinding time 30 per cent compared to time required by ordinary standard weight media. Moreover, the mill lining had worn so little that it was good for 52,500 hours *additional* service, an increase in service life of 300 per cent! *Result: more money for grinding mill operators.*

ALCOA Aluminas and ceramic engineers have a habit of making money for manufacturers. Almost every day someone puts these versatile ALCOA Aluminas to work . . . improving products, cutting costs, increasing production, reducing production time.

If you want to know more about ALCOA Aluminas and what they might do for *your* business, call your nearest ALCOA sales office, or write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 713-L Alcoa Building, Pittsburgh 19, Pa.

ALCOA CHEMICALS

ALUMINUM COMPANY OF AMERICA

STRAINS AND TRANSFORMATION REGION . . .

(*Continued from page* 608)

shape of the sample the same experiment was repeated on a truncated prism 45 mm. long and 10 mm. thick, and on a parallelepiped with edges of 20 × 20 × 75 mm., both of dense barium-crown glass. Figure 10 represents the birefringence as a function of temperature of the block and of the prism, and also refractive index as a function of temperature. The index was measured in the furnace on the prismatic sample. The operation of the furnace was similar during the two experiments; however, the strain curves of the block and the prism differed somewhat. The birefringence induced in the block by rapid heating (250°C. per hour) was 10 times greater than that induced in the prism by the same heating rate. The prismatic shape lessened the phenomenon, the two birefringence maxima obtained for the prism were much less marked than those of the block. The second-maximum of the prism was shifted 50°C. with respect to that of the block. Nevertheless the two maxima, that of the prism and that of the block, began at the same temperature, 550°C. The curve of the block has greater slope starting from 550°C. than that of the prism, so that the curve of the block shows its maximum sooner, at 675°C., than the curve of the prism.

The curve of refractive index as a function of temperature shows a linear rise to 675°C.; then at 675°C., the beginning of the transformation range, a rapid decrease.

These three curves, drawn on the same scale, Fig. 10, prove that in a certain temperature range, the physical constants of the glass undergo abrupt variations determined by an internal change in the nature of the glass. This experiment shows also that the prismatic shape, chosen to enable index measurements during heating, conceals and diminishes the rapid variations of birefringence which would be better ascertained with a parallelepiped sample.

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(3) A. Winter & F. Naudin, Compt. Rend., *231*, 516-517 (1950).
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(*To Be Continued*)

WYANDOTTE STAFF CHANGE

Horace C. Brunner has been named Manager of the Chicago office of Wyandotte Chemicals Corporation's Michigan Alkali Division. A Wyandotte employee since 1930, Mr. Brunner was Manager of Wyandotte's Detroit office for six years. Before being appointed Assistant Manager of the Chicago office for which he now assumes full responsibility, Mr. Brunner served as Manager of Distributor Sales at the company's home office in Wyandotte, Michigan.

Also announced is the appointment of F. M. Zorn as a technical service representative in the Michigan Alkali Division. A chemical engineering graduate of Case Institute of Technology where he received a M.S. degree. Mr. Zorn has been with Wyandotte for 15 years. In his new position, he will assist customers in the handling and use of Michigan Alkali Division products.

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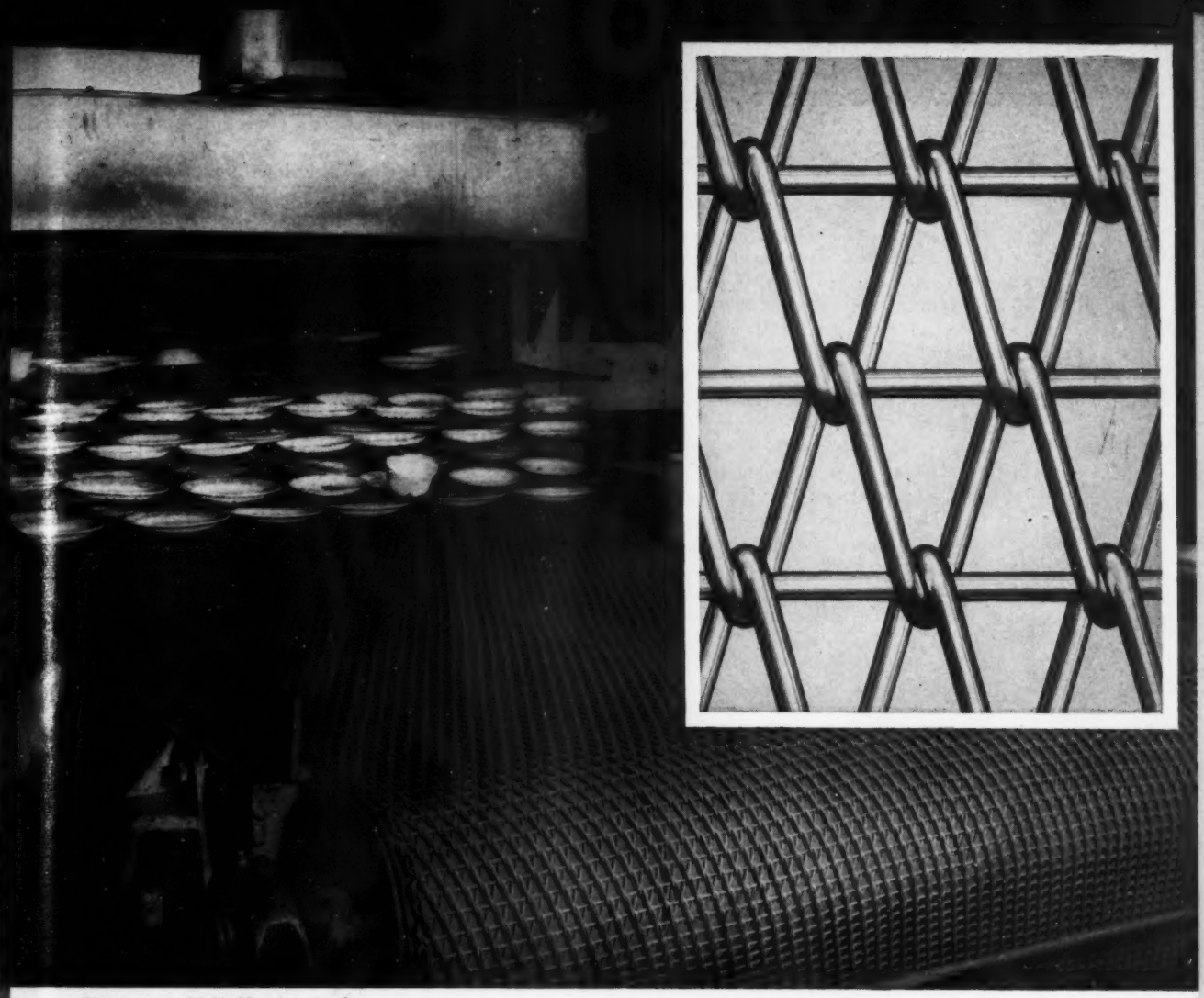

Photo courtesy of Sabin Manufacturing Co.

One WISSCO BELT *leads to another*

Efficient and dependable performance of *modernized** Wissco High-Temperature Belts inevitably leads to repeat orders.

A good case in point is the Sabin Manufacturing Co. of McKeesport, Pa., producers of dinnerware and novelty dishes. In mid-year of 1952, this company installed a Wissco High-Temperature Rod Reinforced Belt with thin spiral and dual continuous reinforcing rod for carrying ware through a lehr, in which decorations are fused to the ware. Products are in the furnace for a 3½ hour cycle at a temperature of 1260° C. The belt travels at a rate of 1 foot every four minutes and is in operation 24 hours a day, 5½ days a week.

So satisfied are company officials with the performance of this belt that recently when they were in the market for a belt on an adjacent furnace, they again specified Wissco—thus amply confirming the fact that "One Wissco Belt Leads To Another".

Why not find out what Wissco's extra durability can mean to you in longer belt life and uninterrupted production. Let us know your requirements.

***WISSCO thin spiral to resist stretch and distortion and WISSCO dual continuous reinforcing rod to prevent narrowing**

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WISSCO BELTS
PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION CF&I

THEORETICAL HEAT INPUT . . .

(*Continued from page* 613)

For the batch in Badger's calculation, a volatilization loss (as CO_2 and SO_2) of 14.7 per cent is given; the net weight of the non volatile ingredients was therefore 30.1 tons of batch, mixed with 69.5 tons of cullet (approximately 30 per cent batch, 70 per cent of cullet). Badger gives the reaction heats (to form, at room temperature, the simple metasilicates of Na, Ca, and Mg from the oxides and silica) as 81.3 BTU for 1 pound of finished glass, or 45,170 calories per kg glass. For 100 short-tons of glass, therefore, Badger has given 4.895 mill. BTU as the heat input required to achieve the thermochemical reactions of the active (raw) batch or equivalent to 1.213 mill. Calories per 30 short-tons of finished glass, and 4,517 Calories per 100 kg glass from the fresh batch. This amount appears to be much lower if compared in Kröger's data (18,211 Calor. per 100 kg), even if we consider the presence of burnt lime (and MgO) in the fresh batch, and deduct all the secondary heat inputs, e.g., by inversions of crystalline phases of the batch and the intercrystalline dissociations of double carbonates. The inevitable heat losses by CO_2 and SO_2 (evolved from carbonate and sulfate containing batches), which escape with the waste gases through the stack, should not be included in the calculation of the total utilized heat energy for glassmaking as Kröger has done. It may be that the data of the International Critical Table, which Badger used in the calculations for the formation of the metasilicates, are not in agreement with the more modern data used by Kröger. This would not change the fact that alone for the metasilicate reactions, Badger's results are about one-half of the heat inputs required in Kröger's. The introduction of the heat effects of the sodium sulfate in the batch is decidedly a new item in Kröger's calculations; it is especially to the credit of N. W. McCready* to have given the first basis for the computation of the heats of homogenization in sodium silicate melts of variable composition.

A relatively good agreement exists in both series of calculations concerning the heat inputs required for bringing the molten glass to the temperature of refining, for which the "end" temperature of 2290°F. = 1250°C. is assumed. Since Kröger's data are calculated for an end temperature of 1500°C., a re-calculation of the specific heat of the molten glass in the temperature range from 20° to 1250°C. was necessary. From the given composition of the glass, and with the constants given for Sharp and Ginther's formula, the specific heat was determined to be 0.2898. The corresponding heat input for 99.35 kg glass is 35,414 Calories, or 128.3 mill BTU per 100 short tons at 1250°C. The sum of the thermochenical reactions in glass melting, and the temperature raising to the finished melt which, in Badger's calculation is 142.4 mill. BTU per 100 short tons glass, appears in Krögers calculation in the amount of 147.97 mill BTU for the same amount of produced glass. It may be incidental that the difference between both results is small; on the other hand, it may speak for the relatively good estimations and calculations of the heat losses by convection, radiation and through the stack. But it would be erroneous to accept both results as final approximations, since also in Kröger's computations so many open problems must appear to the thermochemist which need a thorough and basic investigation.

Finally, it is also highly interesting that the heat input required for melting of the glass from 100 per cent fresh batch in the case of the sheet glass tank furnace would be calculated in the same manner as outlined above, from Kröger's data being 186.2 mill. BTU per 100 short tons of glass, or 61,576 Calories per 100 kg glass. Badger's calculations would yield in this particular case, the heat input utilized for glass melting alone being 12.31 mill. BTU per 100 short tons, which is decidedly too low because the sum with the heat input for bringing the finished glass to the end temperature of 2290°F. = 1250°C. would only be 149.81 mill. BTU per 100 short tons. The economy in the heat input by the use of cullet would be in Kröger's data 38 mill. BTU, in Badger's data only about 7.4 mill. BTU, i.e. 29.4 and 5.2 per cent, respectively. The data of Kröger evidently are in better agreement with practical experience.

Acknowledgment

I wish to express my thanks to Dr. C. Kröger of the Technische Hochschule, Aachen, as well as to the Editor of *Glastechnische Berichte* in Frankfurt am Main for having authorized this discussion of Dr. Kröger's excellent article. Furthermore, I wish to thank THE GLASS INDUSTRY for the permission to use Figures 1 and 2 from their Vol. 28, 1947, 173f., which is an English translation of the original article by Dr. I. Peyches, published in the *Bull. Inst. du Verre*, Sept. 1, 1946, No. 4, 1-15. W.E.

* Journ. Phys. Chem. 52, 1948. 1277-1283.

LITHIUM PLANT TO BE CONSTRUCTED BY AMERICAN POTASH & CHEMICAL

Plans have been completed for the construction by American Potash & Chemical Corporation of a plant for the manufacture of lithium chemicals near San Antonio, Texas, according to an announcement by Peter Colefax, President.

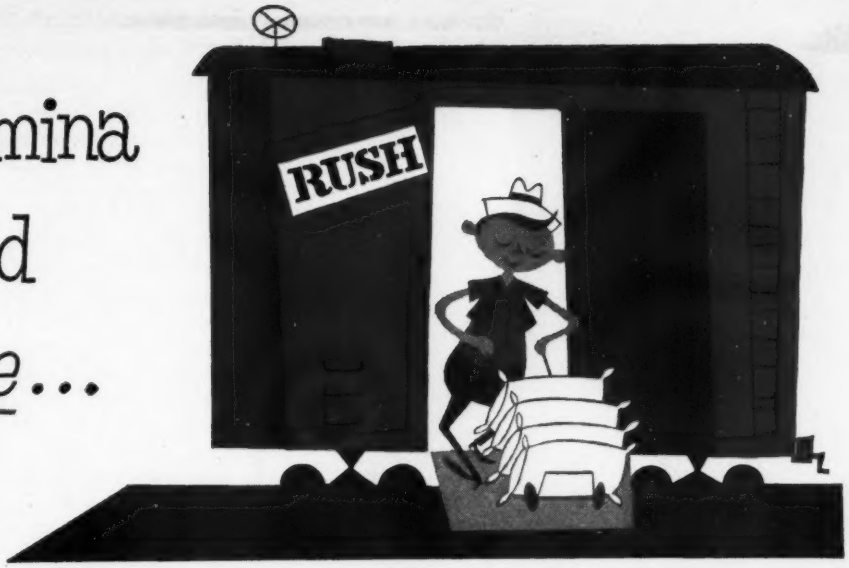
This facility will be owned by a newly-formed company, American Lithium Chemicals, Inc., 50.1 per cent of whose stock is held by American Potash & Chemical Corporation and the balance by Bikita Minerals (Private) Ltd. Lithium ores for the plant will be supplied by the latter company from its large deposits of high-grade lithium ores in Southern Rhodesia, Africa. American Potash & Chemical Corporation already holds a 21.25 per cent interest in Bikita Minerals.

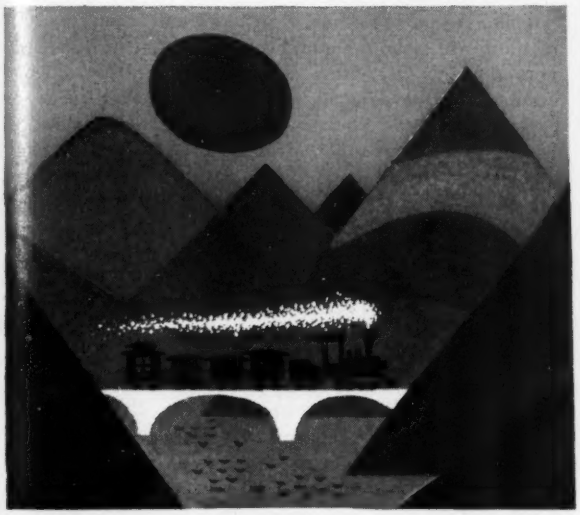
"Addition of the San Antonio plant is a major step in American Potash & Chemical Corporation's program of expansion in the lithium chemicals field," Mr. Colefax stated. "There is a large unsatisfied demand for lithium products as a result of the substantial growth in their use in enamels, ceramics, all-weather greases, air conditioning and other fields."

Initial production at San Antonio will be lithium hydroxide.

• William C. Winterhalter, Executive Vice President and General Manager of H. I. Thompson Fiber Glass Company, has announced the appointment of Kirby Industries to represent the firm in the general industrial field.

Kaiser Alumina delivered *on time*...





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GLASS DIVISION MEETING . . .

(*Continued from page* 602)

entation of very fundamental work on fused silica and was the type of work highly recommended in the panel discussion of the previous day.

Prior to the banquet, a cocktail party sponsored by the Pennsylvania Glass Sand Corporation was held at the Hotel Webster Hall. This party was a most enjoyable one and provided relaxation and an opportunity to chat with old friends and new acquaintances. William J. Woods, Jr. and his associates were the genial hosts and a good time was had by all.

At the annual banquet which was held Friday night, October 8, at Hotel Webster Hall, Dr. Herbert Longnecker, Dean of the Graduate School, University of Pittsburgh, gave a most interesting address, "The Role of the University in Relation to Industrial Research". Dr. Longnecker pointed out the importance and significance of a basic education to our youth in a nation where men are free. He showed statistically that approximately 100 universities carry the chief burden of preparing men for the conservation of our knowledge. Although the college population is a select one, it includes only about one-half of those who have the qualifications. Unfortunately, only approximately two-fifths of those who enter college eventually are graduated. He emphasized that the rapid expansion and the tendency toward greater specialization had brought increased demands on colleges, technical schools and their faculties. Too many projects had also caused an increased burden on such schools and added to the many problems of administration. Dr. Longnecker emphasized that it was very undesirable to constrict unduly the efforts of research personnel, and he recommended that colleges carry out as much basic research as possible.

The industrial research program is dominated by the efforts of twenty larger companies, and of the entire scientifically educated personnel in the United States, about one-fourth are engaged in research problems. To satisfy the requirements of industry, as well as governmental research programs, a strong educational system is not only desirable, but imperative.

The ladies program was ably handled by the following committee: Mrs. D. Owen Evans, Chairman, Mrs. Neill M. Brandt, Mrs. L. Roger Burke, Mrs. C. Burton Clark, Mrs. J. Earl Frazier, Mrs. Charles Gum, Mrs. Frank Jansma, Mrs. C. E. Leberknight, Mrs. Theodore Lenchner, Mrs. R. W. Limes, Mrs. F. W. Mowrey, Mrs. J. S. Nordyke, Mrs. R. Roger Robinson and Mrs. Ralph L. Weaton. On Friday, October 8, a luncheon was held at the Park Schenley in the Oakland district followed by an afternoon of cards and a "Tea Snack" in the Social Room of Mellon Institute. The ladies prizes were won by Mrs. Robert Murray, Mrs. Roy Ehman, Mrs. Charles Greene and Mrs. Theodore Lenchner.

L. G. Burwinkel, Jr. was Chairman of the Golf Committee and golf prizes were as follows: First low gross (84) Dick Hummel; Second low gross (85) Bill Gilluley; Third low gross (88) R. A. Moffet; and Low net, John Matter.

The door prizes were won by Messrs. Glaze, Storey, Simpson, Cassidy, Mold and Kelton.

The presentation of the Forrest and Meyer Awards was also made at the banquet. Trustee Oscar G. Burch

presented the Frank Forrest citation and accompanying check to J. W. Marx and J. W. Sivertsen, University of Illinois, for "Temperature Dependence of the Elastic Moduli and Internal Friction of Silica and Glass", *Jour. Applied Phys.* 24, 81-87 (1953). Dr. D. A. Stuart and O. L. Anderson, Cornell and Bell Laboratory, received the S. M. Meyer, Jr., Award for "Dependence of Ultimate Strength of Glass Under Constant Load on Temperature, Ambient Atmosphere, and Time", *Jour. Am. Ceram. Soc.* 36, 416-424 (1953). It will be recalled that these awards were established by the Preston Laboratories in memory of two young glass technologists who were killed in World War II.

Approximately 50 members remained for the brief business session, which followed the Saturday morning session. The handling of papers, reprints and general policies of the Society in publishing papers were discussed. As a suggestion for program planners, it was pointed out that the Gordon Conference on chemistry may be devoted to glass subjects this coming summer. Further announcements will be made later concerning this conference.

At the Annual Meeting in Cincinnati in April, a symposium on Glass-to-Metal Seals will be presented.

Dr. Charles H. Greene, Head of the Department of Glass Technology at Alfred, announced that a symposium on glass is planned at the New York State College of Ceramics at Alfred University, Alfred, New York, this June. The symposium, which will be a part of the Intersession courses at Alfred University, will be from June 8 to June 25, inclusive. It is planned to have speakers each weekday morning on various glass subjects, and it is hoped that as many members of the Glass Division as possible, as well as representatives from industry, will be present to take part in this symposium. This is a part of the College of Ceramics program to provide a symposium on a selected ceramic subject each summer. Details of the program will be available later and circularized to all members of the Glass Division of the Society.

The Fall Glass Division Meeting for 1955 is planned for September 15 and 16 at the Bedford Springs Hotel, Bedford, Pennsylvania.

GLASS COMPANIES ENTER INTO SALES AGREEMENT

Glenn A. Mengle, President of Brockway Glass Company, Inc., and Kirk Todd, President of The Jeannette Glass Company, have announced that the two companies have entered into an agreement whereby Brockway Glass will have exclusive sales rights to pressed packers ware, such as tumblers and nappies, to be manufactured by Jeannette Glass Company.

Jeannette Glass Company is embarking upon a plant and warehouse modernization and expansion program to enable the company to take care of the increased production necessary to serve food and other packers who use tumblers and similar pressed ware as containers for their products. This entry by Brockway into the pressed container ware field enables it to offer a more complete service to its customers.

• The New Orleans District Office of Bailey Meter Company has moved to larger quarters at 909 South Jefferson Davis Parkway, New Orleans 25, La. This office is under the managership of S. G. Dukelow.

Milestones in Glass Progress

PHOTO COURTESY CORNING MUSEUM OF GLASS

1577 The Verzelini Goblet is the earliest dated piece of English glass on record. Ornate diamond-point engraving on the bowl includes a double monogram, indicating that it was a marriage or betrothal goblet. Verzelini was glassmaker to Queen Elizabeth I. Only eight other examples of his work are known to exist.

1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation (North Plant, above), was founded by Captain J. B. Ford to supply Soda Ash to the glass industry. Wyandotte has grown up with glass. Today, as in the past, it is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

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RESEARCH DIGEST . . .
(*Continued from page* 619)

ing furnace availability in that several hundred tons more glass are produced; (2) fuel and labor are saved; (3) down-time and overhead costs are reduced; (4) the expansion of the crown can be better controlled as it does not give much of an opportunity for the expansion to "sneak by" the heat-up men until it is too late. The major expansion in the crown is over quickly enabling the heat-up men to apply their attention to bottom, sidewall, port and regenerator expansion. It is refractory failure in these portions of a furnace that materially shortens the life of the furnace, either as a unit or individually, since a silica crown seldom fails. The faster the regular firing apparatus can be put into operation and the furnace stabilized as to pressure conditions, the better will be the distribution of temperature in the furnace and checker chambers, thus insuring longer life for the furnace as a unit. (5) The heating-up time of feeders, along with the furnace, is greatly simplified. It is a good practice to schedule the heat-up of the feeders to conform to the heat-up rate of the furnace refining chamber so that fluctuation in pressure and temperature does not damage the feeder refractories in any manner whatsoever.

It is possible that furnaces may be heated up successfully at even faster rates when more knowledge is obtained about the behavior of material used in the bottoms, sidewalls and superstructure of the furnace proper so that precautions and safeguards may be taken to prevent damage to them, such as temporarily insulating the cold face, in order to prevent a great difference in temperature between the hot and cold faces of the blocks.

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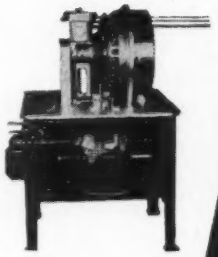

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PUBLIC RELATIONS DIRECTOR NAMED BY OWENS-ILLINOIS

Edward C. Ames has been named Public Relations Director of Owens-Illinois Glass Company to succeed Edwin D. Dodd who was recently appointed Production Manager for the company's Libbey Glass Division.

Mr. Ames, who resigned as Employee and Public Relations Director of Calumet and Hecla, Inc. to accept the O-I position, was Public Relations Director of Owens-Corning Fiberglas Corporation for 10 years. From 1930 to 1934 he was on the editorial staff of The Toledo Times and from 1934 to 1938 served at the University of Toledo as assistant professor of English and director of the University News Bureau.

CORNING APPOINTMENTS

The appointment of George W. Douglas as Manager of Lighting Sales in the Corning Glass Works specialty products department has been announced by Russell Brittingham, Vice President and General Manager of the company's Technical Products Division. Mr. Douglas will direct the sale of Corning's residential, commercial and industrial lighting ware, and supervise activities of the company's lighting field representatives in the United States and Canada.

Associated with Corning Glass Works since 1944, Mr. Douglas has served as a cost estimator and in sales.

Also announced was the appointment of James M. Bierer as Manager of Advertising and Sales Promotion for the company's Consumer Products Division. Mr. Bierer, who joined Corning in 1946, has been active in production control phases of the company's operations.

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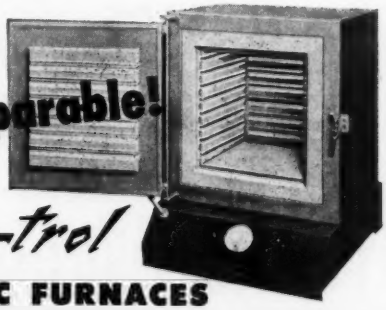

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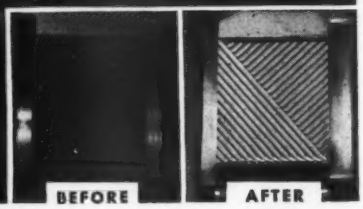

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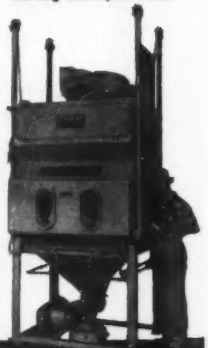

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 618)

wards each end of the header. The brackets are provided with a pitman driven by an electric motor (not shown). On energizing the motor, the fingers are oscillated over a variable amplitude to effect more even distribution of cooling jets on the glass surfaces.

The patent contains 10 claims and the following references were cited: 1,107,072, Houze, Aug. 11, 1914; 1,161,998, Titus et al., Nov. 30, 1915; 1,041,329, Mygatt, July 6, 1920; 2,182,448, Paddock, Dec. 5, 1939; 2,247,118, Drake, June 24, 1941; 2,250,628, Forbes, July 29, 1941; 2,348,887, Drake, May 16, 1944; 2,369,368, Paddock et al., Feb. 13, 1945; and 616,445, Great Britain, July 4, 1935.

FERRO ELECTS PRESIDENT OF THREE SUBSIDIARIES

C. D. Clawson, President of Ferro Corporation, has announced the election of John A. Sullivan as President of Tuttle & Kift, Inc., Ferrod Manufacturing Company and Ferro Electric Products, all wholly-owned subsidiaries of Ferro Corporation. Mr. Sullivan replaces Mr. Clawson who will assume full-time duties as President of the parent corporation.

Mr. Sullivan joins Ferro from General Mills where, until recently, he was Director of Home Appliance Marketing, in charge of all activities related to sales, service, advertising, sales promotion and production service. He had formerly been associated with Robeson-Rochester Corporation and Westinghouse.

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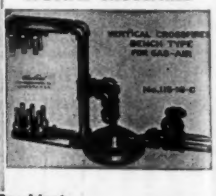

Dr. Charles Eisler M.E., *President*
EISLER ENGINEERING CO., INC. 742 SO. 13TH STREET NEWARK 3, N. J.

COLUMBIA-SOUTHERN APPOINTMENT

Arthur M. Brooks has joined the market research and development department of Columbia-Southern Chemical Corporation.

Associated with the Raffold Process Corporation since 1922, Mr. Brooks served as a Vice President of that firm during the past 24 years. He has specialized in the field of industrial chemistry and chemical engineering, particularly as applied to the pigment and paper industries and in the field of casein manufacture and leather finishes.

KAISER ALUMINA EXPANSION

A $27-million, three-year expansion program raising its capacity to over 800,000 tons of alumina per year is nearing completion at the Kaiser Aluminum & Chemical Corporation Baton Rouge, Louisiana, plant.

The final phase, currently underway, increases the plant's production to provide the alumina requirements of Kaiser Aluminum's reduction plants at Chalmette, Louisiana, and Tacoma and Mead, Washington, with total primary aluminum capacities of more than 400,000 tons per year.

• The Arner Company, a major producer of sulfa drugs, is busy compounding and mass-producing pitch rings like medical tablets. American Optical Company's Instrument Division uses the pitch rings to hold optical glass on blocks for precision grinding. The drug manufacturer was awarded the contract because pitch compounding offers the same production problems as drug manufacture.

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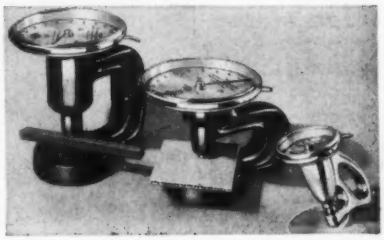

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1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, John T. Ogden, 55 West 42nd Street, New York 36, N. Y.; Editor, Cyril B. Delgado, 55 West 42nd Street, New York 36, N. Y.; Managing Editor, None; Business Manager, Cyril B. Delgado, 55 West 42nd Street, New York 36, N. Y.

2. The owner is: Ogden Publishing Company, 55 West 42nd Street, New York 36, N. Y.; John T. Ogden, 55 West 42nd Street, New York 36, N. Y.; Katherine Waller Ogden, 55 West 42nd Street, New York 36, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

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(Signed)
JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 22nd day of September, 1954.

David M. Cohen
Notary Public in the State of New York
No. 24-5736200
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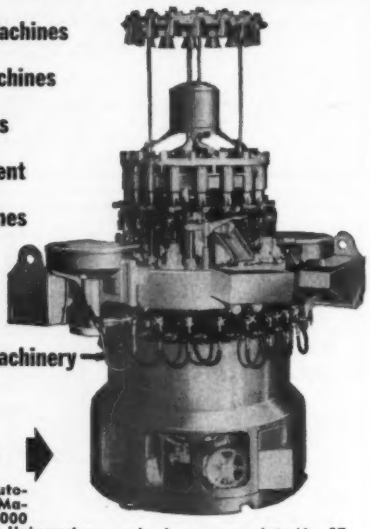

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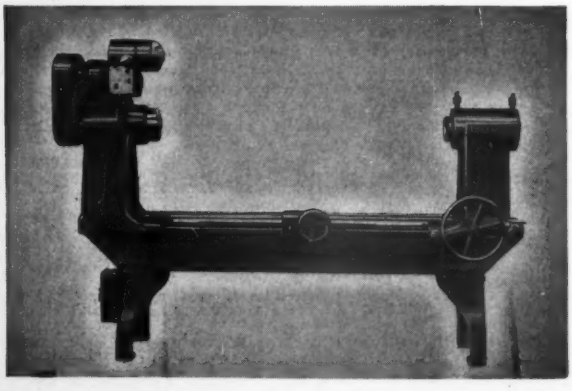

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